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THE GAS JOURNAL

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EDITORIAL NOTES

Making Records

ANOTHER Institution Meeting has come and gone. Gone, that is, so far as the actual gathering is concerned, but yet only on the threshold of the good results to which it must lead. It has been an epoch-making event in many respects, and it has set up as many records as a County Cricket Season. Once more it is necessary to congratulate many good friends, and to say things which we trust no one will regard as the result of justice blinded by sentiment. Rather would we have them assumed to be dictated by justice blinded to sentiment. But writing in the most impersonal way, one can do no less than acclaim the First International Gas Conference and the Sixty-Eighth Annual General Meeting of the Institution of Gas Engineers an outstanding success. At the opening of the business proceedings the hall of the Institution of Civil Engineers was filled to overflowing; and there were large musters at all the outside functions. From first to last the President, Mr. Harold E. Copp, M.Inst.C.E., threw himself heart and soul into the proceedings, and throughout he was assisted by Mrs. Copp in a manner which won the admiration of all. During the week both must have added many strong and valued plants to their already well-stocked Garden of Friends. Mr. and Mrs. Copp, too, will live long in the hearts of those who were with them at the meeting. Here is the purest reward of effort; and we know it is the reward which the President and Mrs. Copp would most desire.

The reception was brilliant, and the thousand persons who were present seemed all to be friends one with another. That was the spirit which animated the proceedings generally. A feature was the large number of distinguished visitors from Overseas, who honoured us with their presence in connection with the First International Gas Conference, and whom it was the great delight of us all to welcome. Then, as was the case at Leeds last year, special arrangements were made for the ladies; so that, with increased duties for the President, the responsibility thrown upon the President's wife has also grown. The greater numbers attending, and the more numerous functions, too, made added demands upon the Secretary, and more than once during the proceedings were Mr. J. R. W. Alexander and his staff the recipients of well-deserved commendation. In fact, the whole proceedings, which passed off without a hitch, constituted a tribute to the organizing ability behind all the arrangements.

Nothing has been said here that goes a step beyond the bare facts. During the meeting efforts were made to unearth anything that might be considered a shortcoming. It was a thankless task; but the search was not entirely unrewarded. It was found that one direction does exist in which improvement must be aimed at in connection with future meetings. It is a trouble which in all probability has existed as long as Gas Institutions themselves. We ourselves, at any rate, remember it for a greater number of years than need be mentioned here. It is, too, a matter in connection with which there was promise of improvement on the present occasion. We refer to the time available for the discussion of papers. The fact should never for a moment be lost sight of that the printed paper is on record for all time, and thus is in no danger whatever of being lost Now the exact opposite is the case with regard to the discussion. No one can possibly tell how many useful suggestions or how much constructive criticism may be lost for ever by inability to leave a discussion open longer. The author is there, on the platform, ready to assist, or to be assisted by, his fellow members. That is the occasion; that is the opportunity. Written contributions are an alternative, but not always a satisfactory one. The meeting is over; normal duties claim attention once again—and so, perhaps, the suggestive query, or the valuable hint, is lost for ever; a good fish has slipped through the net. The Institution needs every fish it can catch. Never were knowledge and information so plentiful, never were still further knowledge and information so urgently needed, as now. With so much indebtedness to acknowledge, we may be forgiven reference to this point, which we feel is a really important one.

A Meeting Extraordinary

NOT in the long history of the Gas Industry has there been such an attendance of members of the Chartered Institution of Gas Engineers and of delegates from Nations Overseas. Fifteen hundred strong were present, and twenty-one nations were represented; and we of the British Gas Industry may well be pardoned for a feeling of pride that the first International Gas Conference should have been staged so admirably in our Capital City. Now there is an International Gas Union, with the distinguished Herr Fritz Escher as first President, and with Mr. H. E. Copp and the Institution's Secretary, Mr. J. R. W. Alexander, as representatives of Great Britain on the Council of the Union. The formation of this body is most definitely a step in the right direction, for it will foster co-operation and facilitate the pooling of information, and it will demonstrate that there is mutuality of interests between nation and nation in the development of gas service for the benefit of a world-wide community. And we regard it as singularly fitting that Herr Escher should have been elected President of this new organization, for he has not merely cosmopolitan ideas, but—what is infinitely more important—cosmopolitan accomplishments. He is, for instance, almost equally at home in French, German, or English, which is not only very delightful, but extremely useful. Similarly an excellent choice has been made in the Secretary of the Union for the President's three-year term of office. M. Pierre Mougin, General Secretary of the Union Syndicale de l'Industrie du Gaz en France, is counted among the personal friends of many an English gas man.

Let us turn to the meeting of the Institution. The papers were excellent. And this year we have had a splendid example of what a short address can be. We refer to Mr. Clifford Paige, the President of the American Gas Association, who held his audience spellbound by his fluent and forceful interpretation of what the American Gas Industry is doing, in face of the keenest type of competition, to develop gas sales and afford its consumers a truly modern service. Not everything in America is either good, or applicable to our own country, but we shall squander money

and waste invaluable time unless we take—and that without delay—more than one leaf out of the notebook of the A.G.A. As Sir Francis Goodenough said during the discussion on Mr. Paige's paper, we in this country are too much inclined to go on from day to day and month to month in our work, instead of looking ahead and planning. We must set out a plan, and settle down to it deliberately. The A.G.A. is a model of co-operation.

We regard as of the greatest importance the paper by Dr. R. Lessing, who has established what Sir Arthur Duckham describes as an "absolute process" for the cleaning of coal. We ought to give Dr. Lessing every encouragement practically, for we are certain that the universal use of clean coal would bring about a new era in the Gas Industry, and we believe that the carbonizing of clean coal would enhance not only our prestige, but also our profits. Apart from a host of other advantages, clean coal means clean coke. Ask any harassed householder whether he would pay a little more for a clean coke—a smokeless fuel with a minimum of ash. Even in straitened times like the present, we have no doubt as to what the general answer would be. Then there was the contribution by Mr. A. L. Holton; and whatever the individual views may be as to the merits of semi-direct recovery of ammonia at gas-works, both he and the contractors of the plant at the Partington Works of the Manchester Corporation are to be congratulated on a bold enterprise. All good luck, therefore, to Mr. Holton; and, like Oliver Twist, we ask for more from him in the future. His paper may be looked upon as a preliminary to a later and more valuable one.

The technical fare of the meeting could not have been better calculated to meet varied tastes. There was a most important paper by Mr. J. S. Thorman, who gave the working results of a new installation of Woodall-Duckham vertical intermittent chambers at the Southall Works of the Gas Light and Coke Company, and demonstrated that this type of carbonizing plant is simple to operate, allows of the use of practically an unlimited choice of coals, and has great flexibility as to both output and quality of gas. The labour required on the plant is light and unskilled, and the quality of the coke produced is excellent. Those whose work lies for the most part on the distribution side of our Industry had ample to interest them in Dr. Schütte's account of distribution practice in Germany. Two outstanding points in his paper were the employment of consumers' governors and the development of the Brandl-Marischka meter. Regarding the latter, as will be learned from later pages of this issue of the "JOURNAL," a British firm of gas plant constructors have secured the rights of manufacture in this country and in several others. As to the discussion on the paper, we are sure that Mr. Lacey's remarks will be studied closely, for they point to an inevitable trend in our Industry.

The other contributions at this memorable conference were by Mr. R. N. Webb and Mr. J. H. Clegg. The former dealt with a problem of pressure control within gas retorts, and showed how important it is to ensure uniformity of pressure conditions, while at the same time he demonstrated his perseverance and ingenuity in tackling the problem at the New Wortley Gas-Works of the Leeds Corporation. Mr. Clegg is fortunate in that he has had the opportunity, which rarely falls to the lot of a gas engineer, to plan and complete a new gas-works on a new site; and the full and detailed information he has given, in regard not only to the design and construction of the plant at the Oswald Street Gas-Works of the Burnley Corporation, but also to capital costs, working results, working costs, and maintenance charges, will be of much value to members of the Institution. A particularly noteworthy feature of the installation he describes is a Sulzer coke cooling plant. There can be no doubt that the dry cooling of coke has a great influence on the development of coke sales. "The coke produced in that way," says Mr. Clegg, "is infinitely superior even to coke which has been quenched carefully, and the difference in the condition of the retort house and the surrounding plant, due to the absence of steam and sulphur-laden fumes, is remarkable."

Altogether, then, it was a meeting extraordinary, and it will be remembered with both pleasure and profit by those who were fortunate enough to participate in the proceedings.

AN HISTORIC PORTRAIT

Thomas Greaves Barlow—one time Proprietor and Editor of the "JOURNAL"

Thomas Greaves Barlow was born on Jan. 10, 1811, and died on Sept. 6, 1872. He was at one time Proprietor and Editor of the "JOURNAL," and the portrait in oils which is reproduced here has lately been rescued in a dilapidated condition from a store room, and excellently restored by Samuel Coombes of 175, Strand, London, W.C. It now finds a fitting place in our Board Room. The artist was P. Levin, who exhibited about a dozen pictures in the Royal Academy between the years 1855 and 1874.

Mr. T. G. Barlow was a son of Mr. John Barlow, who took a great interest in the subject when the use of coal gas was first successfully introduced into London in 1813, and very shortly he formed such a high opinion of the prospects of the new invention that he gave up the iron foundry in Sheffield which he had carried on for some years, and moved to London, where he devoted himself energetically to the design and construction of gas-works, and to the perfecting of the apparatus employed therein. He established a manufactory in the City Road, and aided materially in the introduction of the new light in various parts of England. He was, in fact, one of the earliest "gas engineers;" and although his name has not been associated with any prominent invention or improvement, yet it is well remembered that his skill and care in the construction of apparatus conduced in no small degree to the commercial success, as well as to the public utility, of many of the earlier undertakings for gas supply.

Thomas, at the age of sixteen, entered his father's office, and from that time his connection with the Gas Industry was unbroken to the day of his death. After some years' pupilage, he was, with a younger brother James, taken by his father into partnership, and the gas engineering business was thenceforward carried on under the name of John Barlow & Sons. The firm had offices in Bucklersbury, where the designing, drawing, and consulting business was carried on; and the workshops in the City Road were enlarged, and used more extensively for the practical execution of the works undertaken by the firm.

The chief part of the work devolved on Thomas, who, during the time he was connected with the firm, designed and constructed numerous gas-works, not only in Great Britain, but in many other parts of the world. In 1835 he went to America, where he stayed two years, and superintended the building of gas-works in several rising towns. He also visited many parts of the Continent of Europe, and was extensively engaged there in the same objects.

"JOURNAL OF GAS LIGHTING" ESTABLISHED.

At the beginning of the year 1849, Mr. Barlow established the "JOURNAL OF GAS LIGHTING." About that time considerable agitation had been raised against the Gas Companies of the Metropolis, and especially against two of them, the "Chartered" and the "City" Companies, which jointly supplied the City of London. Several influential members of the Corporation had promoted a new Company, called the "Great Central Gas Consumers' Company," the object of which was to supply the City with gas at 4s. per 1000 c.ft., instead of 6s., the price then charged. So great was the alarm of the old Gas Companies of the Metropolis at this threatened competition, that a panic took place in the gas share market. From January, 1848, to January, 1849, the average fall of the shares was 20 p.ct., and a few months later, as the proposal became more strongly supported, and obtained more favour in the eyes of the authorities, many holders of Metropolitan gas shares

rushed into the market to sacrifice their property at prices in some instances as low as 80 p.ct. under the paid-up capital. The Companies were terrified at the popular cry for "cheap gas," which they believed foreboded nothing less than entire ruin to them.

Mr. Barlow, who had paid great attention to the progress of the agitation, saw at an early period the fallacy of the panic, and the desirability of making some efforts to arrest it; and he resolved, in conjunction with some influential friends, to establish a journal, with a view to supporting the interests of the existing Gas Companies, as well as of circulating scientific and commercial information on the subject of gas lighting generally.

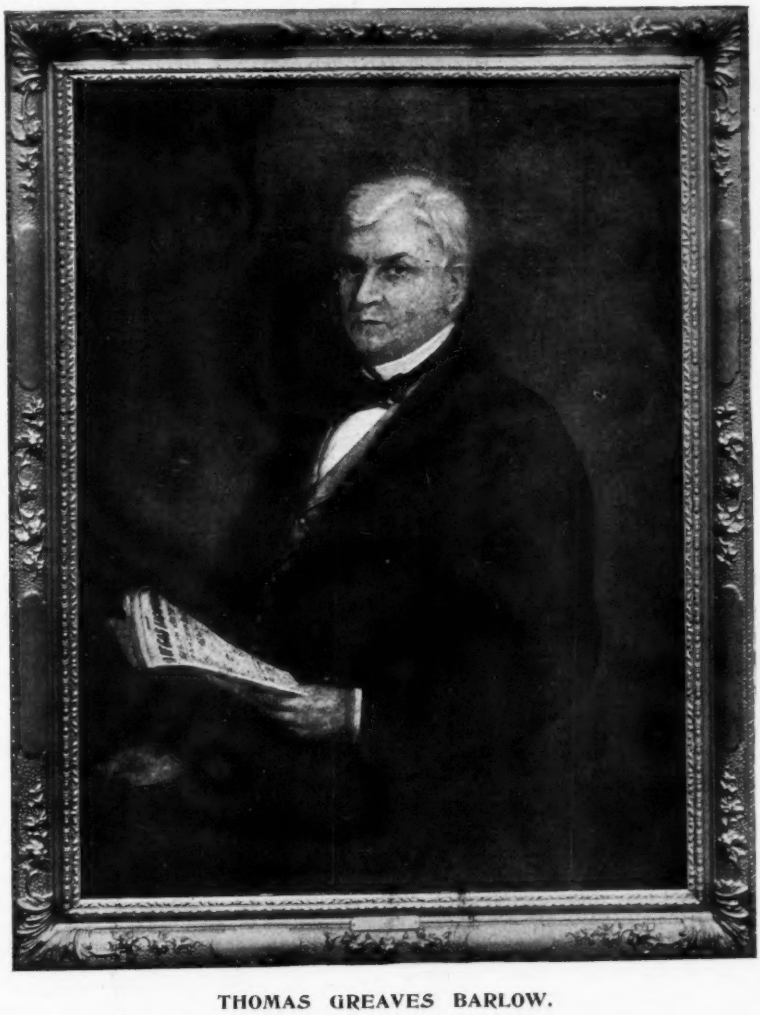
Early Days of Gas.

The first number of this periodical bears the date Feb. 10, 1849. It appeared then only once a month. In the earlier numbers Mr. Barlow strongly opposed the formation of the new Company, but the opposition was unsuccessful, and the Great Central Company became established, and supplied a large quantity of gas in the City. Mr. A. Angus Croll, their Engineer, engaged to produce gas for them at a certain price; but, on the termination of his contract, a dispute arose between him and the Company as to a considerable sum claimed, and, although Mr. Barlow had strongly contested Mr. Croll's views and statements at an earlier period, so great was this gentleman's confidence in Mr. Barlow's experience and integrity, that he appointed him as his Arbitrator—a compliment which Mr. Barlow always spoke of with much gratification.

It was Mr. Barlow's avowed policy to advocate in the "Journal" the interests of the Gas and Water Companies, so far as their proceedings were creditable and just. But he would never give support in its pages to measures of objectionable character, or which he conceived would not tend to the credit of their promoters. He was never slow to point out errors of policy on the part of Managers or Directors, and it was always one of his fixed principles earnestly to advise conciliation of the public, when it could be reasonably offered without material detriment to the interests of the shareholders. This unflinching line of conduct sometimes produced temporary dissensions; but it was favourable in the long run to his own interests, as it procured for the "Journal" an eminently independent character, and won a high degree of confidence for the opinions expressed in its columns.

He never failed to urge on the Companies any line of policy which, though it might not always be palatable, he conceived would be to their real advantage, and would ultimately secure them the support of the public. In the first number, for example, he endeavoured to show that the proper way to meet the threatened competition was by an extensive measure of amalgamation, which would enable the Companies, without loss to themselves, to make reasonable concessions to the public, and so to cut the ground from under their opponents' feet. Subsequently the wisdom of Mr. Barlow's views on this subject of amalgamation was recognized.

Mr. Barlow took great pride in the "Journal" after its success was established. He entirely gave up the manufacturing branch of his former business, and greatly diminished that of the design of works. He still occasionally prepared plans for gas establishments, and superintended their execution; but he preferred to confine his practice to that of a consulting gas engineer. In this branch of the profession his practice became very large. His aid was eagerly sought, not only in his own country, but in all parts of Europe, and frequently in the affairs of the more remote quarters of the globe.



THOMAS GREAVES BARLOW.

This information is extracted from an issue of the "Journal" published shortly after Mr. Barlow's death; and the following are the concluding words of that article: "Mr. Barlow will be long remembered for the aid he has given to gas lighting, and there is no place in which this aid may be more appropriately acknowledged than in the columns of the 'Journal' which, for nearly a quarter-of-a-century, has been upheld and guided by his able hand."

PERSONAL

FALKIRK GAS MANAGER HONOURED.

On May 29 the staff and workmen of the Falkirk Corporation Gas Department met Mr. H. G. RITCHIE, A.M.I.Mech.E., M.Inst.Gas E., and presented him with a barometer, suitably inscribed, and a piece of Dresden china, to mark the occasion of his election as President of the North British Association of Gas Managers. Mr. Wm. Ewing, Assoc.M.Inst.Gas E., Chief Assistant, opened the proceedings, and referred to the harmonious relations existing between the employees and their Engineer and Manager, and he had no doubt these happy conditions would continue. Ex-Provost Muirhead, Deputy Convener of the Gas Committee, in handing over the gifts, congratulated Mr. Ritchie on the high honour conferred on him by his colleagues in the Gas Industry in Scotland. Mr. Ritchie, in thanking the donors for their unexpected kindness, expressed his satisfaction to know that he held the respect of the staff and workmen. In these days of strenuous competition it behoved all employees of the Department to pull together for the good of the Gas Industry.

On Tuesday last week, before going to the Institution President's reception at the Park Lane Hotel, Mr. CLIFFORD PAIGE and Major ALEXANDER FORWARD, accompanied by Sir Francis Goodenough, were received by the President of the Board of Trade in his room at the House of Commons. Mr. Graham, with whom was Mr. Percy Ashley, had a long talk with his visitors on American gas affairs, in which he showed much interest. Through the courtesy of Commander Kenworthy, M.P. for Hull, Mr. Paige and Major Forward were given seats in the Distinguished Strangers' Gallery of the House the next afternoon.

Mr. EDWARD CORBET WOODALL has been appointed a Director of the British Gas Light Company, Ltd., to fill the vacancy caused by the recent death of Mr. Lewis R. Abbey-Williams.

Mr. ALEX. MCDONALD, B.Sc., A.R.T.C., who has been Deputy Gas Engineer and Manager to the Motherwell and Wishaw Corporation Gas Department since May, 1930, has been appointed Gas Engineer and Manager in succession to Mr. John Wilson, recently appointed Gas Manager to the Dundee Corporation. Mr. McDonald, who is an Associate of the Institute of Chemistry and an Associate Member of the Institution of Gas Engineers, holds the Institution's Certificates (First-Class Honours and Distinction) in Gas Engineering and Gas Supply. He was appointed Technical Assistant at the Motherwell Gas-Works in 1924, and became Deputy Gas Engineer and Manager on the completion of the centralization scheme in 1930. In 1927, he was elected to the Council of the Scottish Junior Gas Association, and in 1928 was awarded the Association's Prize, for a paper on the unification of gas undertakings. He was unanimously chosen President of the Association for the current year, and during the past four years has acted in an advisory capacity to the Royal Technical College Joint Committee on the organization of classes in science and technology. Mr. McDonald has also been lecturer and demonstrator in Chemistry and Metallurgy at the Dalziel Technical School for the past six years.

Mr. JAMES BROWN, Manager of the Larkhill Gas-Works, has tendered his resignation, owing to ill-health. Mr. Brown has been connected with the gas-works for 40 years, for 18 of which he acted as Manager under the Larkhill Gas Company, and in the same capacity under the County Council for ten years. The Council have agreed to grant him a superannuation allowance.

Mr. JOHN D. TROUP, M.I.Mech.E., &c., having sold the whole of his share holding in the Engineering Review Publishing Co., Ltd., has relinquished his Directorship and also his position as Managing Editor of "Engineering and Boiler House Review." His new business address is 34-35, High Holborn, W.C. 1, where he will publish his own journals. (Telephone, Chancery 8686-7.)

OBITUARY

COL. H. LE ROY-LEWIS, C.B., C.M.G., D.S.O.

Col. Herman Le Roy-Lewis died at his home in Bournemouth on June 7, at the age of 70.

Colonel Le Roy-Lewis had a most brilliant and varied life. Apart from the high position which he held in the City, he was well-known as a scholar, soldier, and diplomat. Educated at Eton and Trinity College, Cambridge, he was called to the Inner Temple in 1883. His Fellowships of the Royal Geographical Society and the Statistical Society are evidence of his subsequent activities in the field of scholarship; and articles from his pen appeared at various times in the "National Review," the "United Service Magazine," "Baily's," the "National Defence Magazine," "Army Review," &c.

As a soldier he saw much active service during the South African War, finally occupying the post of Deputy Assistant Adjutant General of the Headquarters Staff of the Army. For his services in South Africa he received the D.S.O. and medal with four clasps. In 1912 his services in connection with army organization were rewarded by the conferment of the distinction of Commander of the Bath. Upon the outbreak of war in 1914, he was appointed Military Attaché to the British Embassy in Paris—a post which he filled with great distinction; and he rendered services of inestimable value to the Allies, who honoured him with the following decorations: C.M.G.; Commander, Legion of Honour; Croix de Guerre, with palm; Order of Danilo; Crown of Roumania; White Eagle of Serbia.

In civil life he filled the offices of High Sheriff for Hampshire, Deputy Lieutenant, and Justice of the Peace. His activities in the City are indicated by his membership of the Board of the following Companies: Antofagasta (Chili and Bolivia) Railway Company; Chilian Northern Railway Company; Continental Union Gas Company (Chairman); Imperial Continental Gas Association (Chairman); Primitiva Gas Company; St. John del Rey Mining Company; and the Trustees Corporation. He was also Chairman of various French and Belgian Companies.

His association with the Imperial Continental Gas Association was of old standing, for he was elected to the Board in 1903. He contributed greatly to the Company's success for he was a hard worker and possessed great business acumen, as well as an intimate knowledge of French and of French and Belgian mentality. He was in great measure responsible for the change in the organization of the Company whereby many of its undertakings, which were previously operated directly as branch establishments, were taken over by subsidiary undertakings. He may be said to have played an important part in the rationalization of the gas supply for the whole of Belgium. Colonel Le Roy-Lewis was largely responsible for the revival of the fortunes of the Continental Union Gas Company, which in 1929 was converted into a trust Company. He also contributed to the work involved in the successful re-organization of the Primitiva Gas Company of Buenos Aires.

The funeral will be at West Meon on Thursday, June 11, and there will be a memorial service at St. Botolph's, Bishopsgate, at noon on that day.

A NOTABLE MEMBER OF THE GAS PROFESSION IN CZECHOSLOVAKIA.

We regret to announce the death at Prague, on May 21, at the age of 56 years, of Mr. FRANTISEK TITERA, Chairman for the past eight years of the Committee of the Municipal Gas-Works in Prague, the capital of Czechoslovakia.

Mr. Titera was born in Zizkov, a suburb of Prague, on Dec. 28, 1875, and, after completing his studies at the Gymnasium, entered the civil service as an official of the Bohemian Land Committee, being finally promoted to the rank of Oberrat (Upper Chancellor) in his profession. Shortly after the formation of the Czechoslovakian republic, at the end of the war, Mr. Titera retired from the civil service, and became member of both the Greater and Inner Councils of the City of Prague, occupying many honorary offices in the municipal interest.

During the regime of Mr. Titera, a magnificent new gas-works, which may be described without exaggeration as one of the finest and most modern in Europe, was built on an entirely new site in Prague to replace three old gas-works of an obsolete type. English readers will remember that the carbonizing plant comprised an installation of continuous vertical retorts on the Glover-West system.

During the last half-dozen years Mr. Titera made several visits to towns and cities in England, notably London, Manchester, and Stratford, to study various phases of English municipal life. He was extremely sympathetic towards British ideals and will be very sincerely mourned by his British friends.

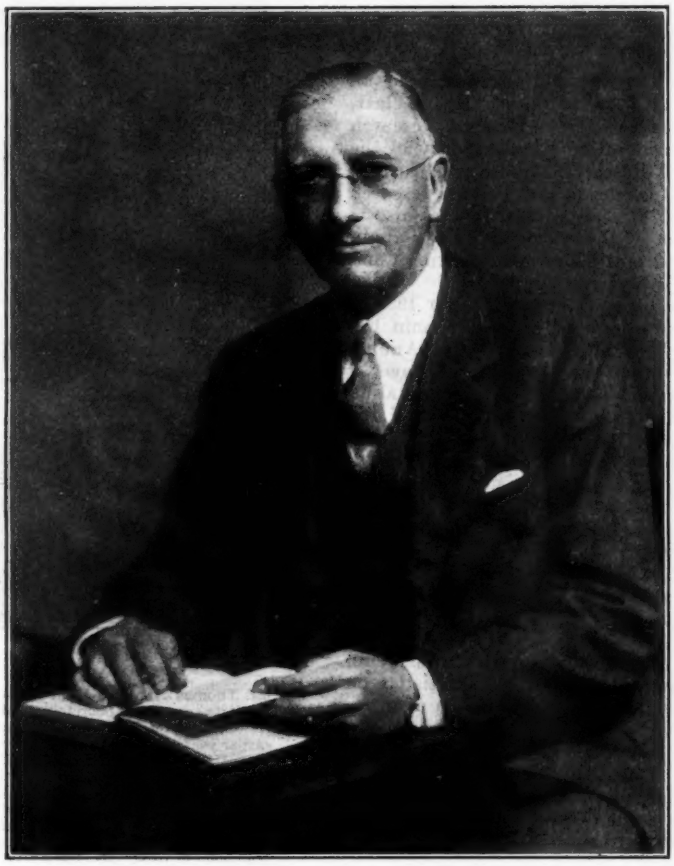
INSTITUTION OF GAS ENGINEERS

Review of Proceedings

at the FIRST INTERNATIONAL GAS CONFERENCE and ANNUAL GENERAL MEETING of the Institution in the Great Hall, Institution of Civil Engineers, London, June 2, 3, and 4, 1931

PRESIDENT - HAROLD E. COPP, M.INST.C.E.

This meeting—unique in both numbers and representation—is of great significance. It ranks among the most inspiring events the Gas Industry has ever staged, and in more respects than one is a landmark in the history of our Institution



HAROLD E. COPP,

Engineer and Manager of the Hull Undertaking of the British Gas Light Company, Limited.

Mr. Copp is the youngest son of the late Mr. W. L. Copp, who was closely associated for many years with the gas industry in the West of England, and was inventor of the first anti-dip valve for attachment to hydraulic mains, used extensively by London Gas Companies about fifty years ago. Educated at Wycliffe College, Mr. Harold Copp began his career in the gas industry in 1892 as a pupil under the late Mr. Fletcher W. Stevenson, at that time Engineer to the Sheffield Gas Company. Later, he acted as clerk of works on the construction of the Grimesthorpe station of the Sheffield Gas Company, and acquired considerable experience on large civil engineering works. He studied at Sheffield University College, gaining certificates in technical subjects, including civil engineering, metallurgy, and chemistry. In 1896, Mr. Copp left Sheffield to become engineering assistant to the Stockport Corporation Gas and Electricity Department, and was subsequently appointed Assistant Gas and Electrical Engineer. In 1902 he went to West Bromwich to take charge of the Corporation Gas Undertaking, where he designed and carried out many improvements and additions to the works. He also conducted a series of experiments on the enrichment of blue water gas by Peebles oil gas plant, worked in conjunction with the Dellwik-Fleischer blue water gas plant. In 1908 he was elected President of the Midland Association of Gas Managers. Mr. Copp's connection with the British Gas Light Company began in 1914, when he was appointed Engineer and Manager of the Potteries station, where he was responsible for the erection of one of the first plants for the production of benzole and toluol. The design of this plant was afterwards adopted by many other gas-works. On the retirement of Mr. John Young in 1919, Mr. Copp was transferred to the Hull Station, and since that time the works and plant have been largely extended and improved under his administration. The nominal capacity of the coal gas plant at the present time is 10,392,000 c.ft. per day, and that of the water gas plant, 4,300,000 c.ft. per day.

Unique.

We are always careful about using the word " unique," but on this occasion we can use it with impunity, for in more than one respect the Institution Meeting held last week was unique. Never before have such numbers forgathered, either in London or elsewhere, to an Engineering Conference representative of our Industry. Never before has the meeting been so cosmopolitan. When Mr. Copp rose on Tuesday morning on the platform in the Great Hall of the Institution of Civil Engineers he was faced by what cannot but be described as an overflow meeting—and our readers know the seating capacity of the Great Hall. Exactly how many were present it is impossible to say, but an indication is given by the number of acceptances for the meeting—1500.

It was only natural that the President's first duty should be to welcome the representatives from other countries to the First International Conference which has been held, and in doing so, he said how proud he was that this event should be in London. A list of those welcomed by the President is given in our report, on later pages, of the International Gas Conference on the Wednesday morning.

Following this welcome we commenced the business of the Annual General Meeting of the Chartered Institution of Gas Engineers, when the President moved that the Annual Report for 1930-31 be taken as read and adopted—a motion which met with no comment.

A Central Research Laboratory?

In the Annual Report for 1930-31, which showed an increase of membership, at 1444, of 39 at Dec. 31 last, reference is made to the fact that the General Research Committee have under consideration the possibility of the establishment of a Central Research Laboratory, further co-operation between the Institution and private research laboratories and the Fuel Research Board, and also a scheme for the certification of the efficiency of gas appliances. It is also mentioned that the Street Lighting Committee will shortly issue its first report.

The Report of the Gas Education Committee for 1930-31 and in future years will be presented at the Autumn Research Meeting instead of, as hitherto, at the Annual General Meeting, in order that the Report shall cover a complete educational year and comprise the examination results. During the past year the administration of the Education Scheme and the work of the Board of Examiners and Assessors have been entirely re-organized. Mr. J. S. Thorman has been elected Chairman of the Board of Examiners in the place of Mr. W. J. Smith, who has resigned, and Mr. J. G. Clark has been appointed an Examiner in Gas Supply. Appreciable progress continues to be made under the Education Scheme, the number of candidates for the 1931 Examinations showing an increase (entirely among internal students) of over 15 p.ct. over any previous year.

A feature of the year is that increasing recourse is being made to the Institution for information and statistics on technical and other matters; and the co-operation of members is sought in rendering to the Secretary adequate reports of accidents in their respective areas which they consider to be of interest to the Gas Industry.

At this point Mr. W. E. Dean, of Exeter, and Mr. W. B. McLusky, of Halifax, were appointed as Scrutineers for the election of Officers for the Institution.

Presentation of Medals.

The President then announced that the Birmingham Medal had been awarded to Mr. Thomas Hardie, Chief Engineer of the Gas Light and Coke Company. This medal is one of the greatest distinctions which the Institution can confer, and it is only awarded as a mark of special recognition of the outstanding service rendered to the Industry over a number of years. The medal was founded in 1881 by the Midland Association of Gas Engineers and Managers to enable the Gas Industry to recognize merit and assiduity in connection with the manufacture and the application of gas; since its institution it has only been awarded upon eleven occasions. The first recipient was Sir George Livesey in 1882, and the last recipient Dr. Charles Carpenter.

When Mr. Hardie stepped on to the platform to receive the medal it was the signal for enthusiastic applause. In a dignified reply he said he experienced, on being told of the award, a thrill of pleasure and a feeling of pride more frequently felt by younger men than by those who had reached his mature age; and he looked upon the presentation as a token of the Members' good will to him personally. It was, he said, a presentation which added to the debt which he already owed to the loyal and capable staff which supported him in his work and his responsibilities.

It is now thirty-five years since Mr. Hardie obtained his first position in a gas undertaking—an undertaking in which at that time his father had held a position of responsibility for over forty years. " During these thirty-five years," remarked Mr. Hardie, " I have received many acts of kindness and much assistance from my engineering brothers and colleagues, and to-day you place me once more under a great obligation to you."

Then came the presentation of the H. E. Jones London Medal, which was awarded to Mr. E. G. Stewart for his paper on " The Functions of Coke Ovens," which was read at the Institution Annual Meeting, 1930. This is the first time that the Medal has been awarded to an officer of the Gas Light and Coke Company.

This year the Institution Silver Medal was a joint award

THOMAS HARDIE.

Mr. Thomas Hardie is a son of the late William Hardie who was for forty-two years Secretary, and later General Manager, of the Newcastle-upon-Tyne and Gateshead Gas Company. Mr. Hardie's earlier years in the Gas Industry were spent in the Tynemouth and Newcastle-upon-Tyne Gas Undertakings, and he was Chief Engineer of the latter Company from 1909 till 1920. He left Newcastle for London in that year, becoming Chief Engineer of the Gas Light and Coke Company in 1922. Mr. Hardie was President of the Institution in 1922, of the North of England Gas Managers' Association in 1906, and of the Southern Association of Gas Engineers and Managers in 1927. Mr. Hardie is a Member of the Institution of Civil Engineers and a Fellow of the Institute of Fuel.

—to Mr. A. L. Holton and Mr. H. C. Applebee, of the Manchester Corporation Gas Department, for their paper on " The Utilization of Coke Breeze by the Trefois Producer."

The final award was the Institution Bronze Medal, which was presented to Mr. S. K. Hawthorn, of Birmingham, for his paper on " Oxide Purification." Regarding this Medal, the President said he ought to pay a tribute to the excellent contributions which are received from time to time from the Junior Associations of our Industry.

There was then a temporary break in the programme when the President said that he had received a telegram of good wishes from Mr. J. P. Klumpp, of Philadelphia, who for twenty-five years has been a member of the Institution of Gas Engineers.

An Event of Historic Importance.

At this stage in the proceedings Mr. Copp delivered his Presidential Address. He referred to the meeting as one of historic importance, as being the First International Gas Conference convened with the assent and co-operation of the National Gas Associations throughout the world, and the first conference to be held under the statutes of the International Gas Union.

Mr. Copp, having condemned municipal opposition to gas, and touched upon the relationship between employer and employed in our Industry, spoke of the limitations of rationalization. "It is," he observed, "a common practice nowadays to speak of rationalization as a way out of all our national difficulties, and well it may be, if it is in fact rational in its application to the industry concerned. The Gas Industry has followed the practice to a logical extent, for, as we know, during the past few years there have been many instances of small gas undertakings amalgamating with larger ones, and so enabling the community concerned to be supplied with gas on more favourable terms. There are, however, limitations to such amalgamations, since the economies in manufacture must not be exceeded by the added costs of distribution. . . . It would be a negation of the idea of rationalization if the coke oven owners were to be given the power to distribute their surplus gas to the consumers of statutory gas undertakings, if for no other reason than that they have no adequate experience of the problems of the distribution of gas and its utilization for manufacturing and general purposes." Rationalization, too, tends to eliminate personal contact between employers and employed; and the President urged all responsible for management to be as accessible as possible to every employee.

E. G. STEWART.

Mr E. G. Stewart is a native of Portsmouth, and received his Technical Education in Civil, Mechanical, and Electrical Engineering at the Portsmouth Municipal Technical College, and later at the Northampton College, London. He entered the Gas Industry in 1906, serving three years in the Shops and Drawing Office of the Portsmouth Gas Company under Mr. J. D. Ashworth, M.I.Mech.E. In 1909 he left Portsmouth to become an Engineer Staff Pupil of the Gas Light and Coke Company, and was appointed a Junior Assistant Engineer of that Company in 1912. Commencing at the Beckton Works, he was transferred the following year to Fulham as Chief Assistant, receiving the rank of Senior Assistant Engineer in 1917. In 1922 he left Fulham to become Station Engineer of the Ilford Works, newly acquired by amalgamation, and upon the closing-down of the works he went to Westminster as Assistant to Mr. Hardie, the Company's Chief Engineer, the position he now holds. Mr. Stewart holds the Bronze Medals of the City and Guilds Institute in Gas Engineering and Gas Supply, as well as the Complete Honours Certificates in both subjects. He is a member of the Institution of Gas Engineers, of the Institute of Fuel, of the Southern Association of Gas Engineers and Managers, and of the London and Southern District Junior Gas Association. For some years he was Treasurer of the last-named. Mr. Stewart, besides his contribution to the Institution last year, has presented papers before the Engineering Conference of the Institution of Civil Engineers, the Swedish Academy of Engineers, and the London and Southern District Junior Gas Association on various subjects connected with carbonizing, water gas, and waste heat recovery.

H. C. APPLEBEE, A.I.C., F.C.S.

Mr. Applebee was born in London and educated at the Central Foundation School, Cowper Street, E.C. He was awarded the Mitchell Exhibition in 1902, and proceeded to City and Guilds Technical College, Finsbury, where he was awarded the Certificate of the College (Department of Technical Chemistry) in 1905. Subsequently he held posts as Assistant Chemist in the Laboratory of the Gas Light and Coke Company, Tar and Ammonia Products Works at Beckton, and as Works Chemist with Messrs. Major & Co., Ltd., of Hull. He was appointed Works Chemist to the Manchester Corporation Gas-Works at Bradford Road in 1914; and he is now Chief Chemist to the Manchesfer Gas Department. Mr. Applebee was President of the Manchester and District Junior Gas Association 1929-30.

S. K. HAWTHORN.

Mr. Hawthorn was born in 1901, and educated at Waverley Road Secondary School, Birmingham. He matriculated in 1917—First Class Inter. Science, 1918. He joined the staff of the Birmingham Gas Department in 1918, and served two years in the Laboratories, seven years in the Drawing Office at Saltley Works, two years as Junior Engineer and Shift Supervisor at Nechells Works, and was appointed Carbonizing Superintendent at the Windsor Street Works in December, 1929. First Class Gas Engineering Diploma, 1929.

Certification of Gas Appliances.

On this topic, Mr. Copp said that most of his hearers would watch with interest the deliberations which have been initiated by the Institution in connection with the possibility of inaugurating a scheme for the certification of gas appliances. It would involve increased co-operation between the Institution and private research laboratories, the collation of existing information, and, ultimately, the provision of additional research staff, including a distinguished chemist and physicist, and a laboratory equipped with adequate apparatus.

Those who believe that the Gas Industry is necessarily opposed to the principle of low-temperature carbonization should note Mr. Copp's remarks. "If," he said, "better methods for the treatment of coal are evolved, the Gas Industry will have no difficulty in financing such improvements. The confidence of the public is a sure indication of the position of the Industry." He also suggested that the production of oil from coal is a line of research which may be profitably pursued by gas undertakings possessing the necessary resources.

Pleasant Co-operation.

In proposing a vote of thanks to the President for his Address, Mr. Henry Woodall, Chairman of the British Gas Light Company, Ltd., spoke of the pleasant co-operation between himself and Mr. Copp in their work. "Mr. Copp," he said, "has filled the position of President with dignity and ability, and in his address has expressed definite and clear opinions which we shall study with both pleasure and profit." Mr. Woodall mentioned that Mr. Copp was the third President of the Institution who had come from the ranks of the British Gas Light Company; Mr. Thomas Glover being President in 1909 and Mr. John Young in 1916.

The seconder of the vote of thanks was Mr. C. C. Allison, Associate Member of the Institution and President of the Institution of Electrical Engineers, who spoke most graciously. "Mr. Copp," he remarked, "exemplifies in a very high degree that body of able public utility engineers who are to be found equally in the Institutions of Gas and Electrical Engineers." Characterizing competition as being good for the public, he said he was confident that, with engineers like Mr. Copp, whether they were at the head of gas or electrical concerns, whatever rivalry or competition there was would always be clean and healthy.

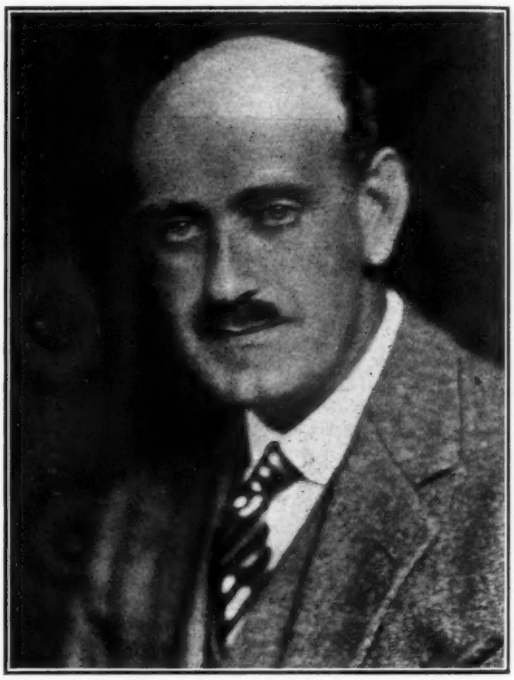
A Noteworthy Installation.

The first paper to be presented at the meeting was by Mr. J. S. Thorman, of the Gas Light and Coke Company, and it is a contribution of the greatest importance to our industry, for it deals with the results of working a large carbonizing unit of Woodall-Duckham intermittent vertical chambers of the latest type. The plant, which was erected in 1930 and put to work in October of the same year, has a capacity of 10 million c.ft. a day, and is complete with coal and coke handling plant. The new unit (and coke transporter), with a daily production of 54,000 therms, occupies practically the same ground space as the inclined retort house which it displaced and which had a maximum production of 13,500 therms. Regarding the choice of plant, Mr. Thorman explains that the determining factor was that Durham coals could be transported by sea to Beckton, transhipped to Brentford, loaded on to rail there, and delivered at Southall at considerably less cost than railborne coal. Thus the plant chosen had to carbonize Durham coals efficiently, and the advantage of steaming favoured the adoption of verticals. Durham coal is being carbonized efficiently in continuous verticals at several of the Company's stations, and it was considered advisable to obtain experience with Durham coal in intermittent vertical chambers, provided they could show satisfaction in regard to capital cost, labour cost, life, maintenance, fuel consumption, and coke quality. Evidence was obtained as to their suitability under such conditions. The plant, which is fully detailed by Mr. Thorman, is in two 5-million sections, each of 48 chambers. Each chamber, which is constructed of silica material throughout its heated height, has a capacity of 3·6 tons of coal.

A plant for the electrical precipitation of tar was fitted in connection with the installation. It is positioned at the outlet of the retort house collecting mains, in order to effect the earliest separation of tar and liquor, and the gas is treated at a temperature above the dew-point. Tar precipitation is very efficient—99·9 p.ct. The precipitated tar is suitable for making road tar, without requiring distillation. By thinning with creosote oil, a tar up to the B.E.S.A. Specification (Tar No. 3) can be readily prepared.

Complete Vindication.

As to the operation of the plant, the labour for the first section of 5 million works out at 4 men per million c.ft. of gas made; with the second section at work, the figure will be 3·4 men per million. The producers give an excellent gas and at the same time are capable of gasifying 10 lbs. of coke per hour per square foot of grate area. Scurfing of the chambers—carried out once every 12 days—is a simple routine matter. A regulated supply of air is allowed to flow through the chambers, and no tools are employed. The carbonizing results are extremely good, and the contractors' guarantees of the plant capacity and thermal efficiencies have been considerably exceeded. Making a gas of 510·4 B.Th.U. over an official 28-day guarantee test, 79·71 therms per ton of coal (ash and moisture content 10·45 p.ct.) were obtained. This is equivalent to 81·88 therms with coal containing 8 p.ct. ash and moisture, the contractors' figure on this basis being 78 therms. Of particular interest is the flexibility of the plant as regards the production of gas with a calorific value of either 550 or 450 B.Th.U., or any intermediate value. The results indicate that the chambers can produce approximately the same volume of gas per day at any calorific value from 550 to 450 B.Th.U. without any appreciable variation either of the amount of fuel consumed in the producers per day, or of the temperatures carried in the combustion flues—*i.e.*, with approximately the same fuel consumption per 1000 c.ft. of gas made at any calorific value in the range mentioned. Tests were made to determine the minimum output of the plant, having in view the benefit of keeping the chamber ovens at work during summer months when demand is low, and avoiding damage to settings and chambers by letting out. The extraordinary flexibility of the plant is demonstrated by comparing the results of the



J. S. THORMAN.

Mr. J. S. Thorman served for 15 years in the West Ham Gas Company, and in 1910, when this Company was amalgamated with the Gas Light and Coke Company, he was transferred to Beckton as Assistant Engineer. He was appointed Deputy Resident Engineer at Beckton in 1916, and an Engineer at Bow Common in 1920 and Stratford in 1921, a position he held for five years. He was appointed to Southall as Engineer in 1926.

maximum output (at 509 B.Th.U.) with those of the minimum output (at 506·5 B.Th.U.). This flexibility of output, expressed as a percentage reduction on the maximum, is as follows: Coals carbonized, 35·2; therms produced, 37·4; and gas made, 37·0. With such a reduction, the fuel consumed per ton of coal carbonized is actually lower than in the corresponding maximum output tests. And Mr. Thorman emphasizes two noteworthy features which have given the greatest satisfaction with the plant: The low percentage of nitrogen in the gas made, and the high steaming efficiency. Even during prolonged steaming the efficiency of steam decomposition is good.

The coke nuts produced are particularly suitable for domestic boilers, as their fuel capacity is increased owing to the higher density—a decided advantage in small domestic boilers with limited fuel capacity; and the coke burns very satisfactorily in open coke grates of modern design.

A Quotation.

At the conclusion of his paper, Mr. Thorman says: "The experience with the intermittent chambers and coal handling plant which have been in operation for six months has proved them to be among the most economical and efficient installed by my Company, and I have no doubt that when the coke plant is finished it will also prove to be equally economical and efficient in the production of clean and well-graded coke most suitable for our customers."

A Plant of Great Flexibility.

Due to lack of time the discussion on Mr. Thorman's paper was meagre, and the President asked members to submit their comments in writing to the Institution. He wondered why the author appeared to have given no consideration to the question of separate mechanical producers in connection with his installation of chamber ovens.

Mr. H. C. Smith, of Tottenham, who accompanied Mr. Thorman on his visit to Germany prior to the installation of the plant at Southall, said how impressed he was by this type of carbonizing unit, with the simplicity of its design and operation. "It is," he said, "a plant for which there is practically an unlimited choice of coals. It has great flexibility in regard to gas output, and the labour needed is light and unskilled." As for the life of the chambers, this, he maintained, should be quite as long as, if not longer than, that of either horizontal or continuous vertical retorts. Concluding his remarks, Mr. Smith said that the author and the makers of the plant were to be congratulated on the excellent results obtained.

This concluded the business of the first Session, and those attending the Conference then repaired to the Horse Guards Parade, where a group photograph was taken.

Distribution in Germany.

The afternoon session on Tuesday was commenced by a paper by Dr. H. Schütte, of Bremen, immediate Past-President of the German Gas and Water Association, on "Problems of Modern Gas Distribution." The author first of all points to the fact that the times when gas undertakings confined themselves to the supply of a small district have passed, and he then refers to the development of long-distance transmission, explaining that the high-pressure mains for this purpose in Germany have reached a total length of 3320 miles. In Germany, distribution problems similar to those in this country have had to be faced. As in England, increased use of gas, especially by industrial consumers, led to inadequacy of existing low-pressure mains; and the industrial load imposed new demands in regard to pressure, because in this field uniformity of pressure, to allow complete control of heating processes, is essential. In certain instances an increase of district pressure satisfied these demands, but in far more cases it was necessary to adopt the principle of de-centralized pressure control by employing separate feeder mains which supply different parts of the low-pressure district mains through district governors. In this connection Dr. Schütte mentions that Vienna has adopted this system on an extensive scale.

To carry de-centralization of pressure to its logical conclusion, the theoretical ideal is to fit a separate governor to every gas appliance—an ideal which at present, however, is ruled out financially as far as domestic supplies are concerned. In several cases in Germany, however, a compromise has been made by installing a "domestic" governor on the inlet of every consumer's meter—a system which obviates the necessity for feeder mains and permits greater differences of pressure on the district. This method of pressure control has been adopted by the municipal gas undertaking in Berlin. The pressure is kept at 2½ in. W.G. only in the old parts of the city; it has been raised to 4¾ in. in the other parts of the district, where 500,000 domestic governors have been installed. This is a matter of great interest. An alternative scheme, embodying a district pressure of 12 to 20 in. (maintained either by boosting or from high-pressure mains) and, where needed, service governors, is described; industrial consumers requiring large quantities of gas are supplied from high-pressure mains. This scheme is really a "three pressure range" system. On the general aspect of the matter, Dr. Schütte states that "the adoption of higher distribution pressures and the de-centralized control opens new possibilities for the further development of the Gas Industry, and provides opportunities for an increase in gas consumption. . . ."

DR. H. SCHÜTTE.

Dr. Schütte is Chief of the Bremen Municipal Gas and Water Undertaking. He was born in Bremen on April 11, 1870, and was educated at the Technical University of Hanover and the Erlangen University. He was appointed Assistant at the Bremen Gas-Works in 1899, and Manager in 1902. He has been Manager also of the Water Works since 1928.

Developments in Meter Design.

The other main section of Dr. Schütte's paper is concerned with gas measurement; and he states roundly that, with increased pressures, only high-capacity meters should be installed which give a low differential pressure and possess a calibration curve practically unaffected by the rate of gas consumption. During recent years much attention has been paid in Germany to the design and construction of the dry gas meter, the practical outcome of which has been a great increase in capacity and sensitiveness, and a calibration curve much less dependent on the rate of gas consumption. The author maintains that the mass production principle adopted in meter works, with intermediate examination stages, has produced a considerably better article than the ordinary method of production, to which some manufacturers still adhere. And he remarks that the annual saving accruing from improvements in meters has been estimated by a large gas undertaking at 4s. per meter installed.

Dr. Schütte speaks very highly of the Brandl-Marischka

displacement meter for the measurement of large gas volumes, which, he suggests, appears likely to replace the ordinary station meter. As to the rotary meter, the orifice and orifice plate, the Venturi tube, and the revolving impeller meter, he says that "none of these measuring devices is accurate at varying loads, and must be considered as a makeshift."

We would call the attention of our readers to the fact—as announced in the later columns of this issue of the "JOURNAL"—that the sole licence for the manufacturing and selling rights in Great Britain and the Colonies, France, Spain, and Belgium for the Brandl-Marischka meter has been secured by Messrs. W. C. Holmes & Co., Ltd.

Governing and Gas Lighting.

All present at the meeting were greatly impressed by Dr. Schütte's clear outline of his contribution—an outline which he gave in English. In this he was assisted by Dr. G. W. Anderson, who had translated the paper, and who subsequently replied to two or three of the points raised during the discussion.

Opening the discussion, the President said he was one of those who advocated very strongly the use of consumers' or district governors, because gas lighting depends entirely upon equable pressure. The next speaker was Mr. Stephen Lacey, of the Gas Light and Coke Company, who said how valuable the paper is, in that it presents familiar problems of gas distribution in a new light. Having referred to the increasing importance of the incidence of distribution costs on the competitive strength of the Gas Industry, Mr. Lacey remarked how glad he was that the author had laid special emphasis on the effect of maintenance of constant pressure on the efficient working of gas appliances. He thinks that we do not all fully recognize the importance of preventing a pressure available at peak loads from being exceeded at other times, and he gave an example of the adverse effect of fluctuations in pressure on the efficiency of gas heating appliances. He suggests that in new districts we could achieve our object of ensuring uniform pressure at appliances at a lower cost if we resorted to the use of governors on our consumers' premises. He mentioned that Dr. Schütte's "domestic" governors correspond to our service governors.

A Prevalent Misconception.

What is the true function of a governor? This question was answered very clearly by Mr. Lacey, who said how remarkable it is that many people, some of them in the Gas Industry, think that a service or appliance governor is an instrument primarily intended for preventing waste of gas, whereas the chief function of service or appliance governors is to enable the gas-consuming appliance to develop its full heating capacity at peak loads. Mr. Lacey has no doubt that governors will in the course of a few years be much more in use for industrial purposes.

Mr. Ralph Gibson, of Liverpool, took up the cudgels in the cause of the wet meter, and suggested that the author has overlooked the fact that most wet meters to-day are made with a compensating device for maintaining the water level. "I think it is indisputable," said Mr. Gibson, "that the wet meter is a more accurate measuring instrument than the dry meter, if the water level is maintained." Ever since its formation the Liverpool Gas Company has used wet meters.

Mr. A. M'I. Cleland, of Belfast, who spoke of the effect on domestic consumers' lighting burners of the pressure-wave system of street lighting control, also had a good deal to say on the inadequacy of the usual burlap and bitumen covering as a protection against the external corrosion of steel mains. Even when a steel pipe is laid in a trough filled with bitumen, he doubts whether this is a safe protection.

Mr. A. T. Gilbert, who joined in the discussion as a meter manufacturer, is of the opinion that there is an appalling apathy on the part of our Industry towards the accurate registration of gas on consumers' premises. On the question of loss of pressure through meters when there is low district pressure in any particular area, it is often possible to gain several tenths of an inch pressure by putting in meters having a more adequate service and flow. Concluding his remarks, Mr. Gilbert said: "I do not like a slur being cast upon the old wet meter. I am sure if we had some on our district we should get more equable registration when compared with the station meter."

In the course of a brief reply, Dr. Schütte said that at Bremen ten or twelve years ago 80 p.ct. of the meters were of the wet type, and he felt at that time that the wet meter was the most reliable. The reason for the change to the dry meter was that the wet meter could not be overloaded. On the other hand, dry gas meters having very high capacity have been evolved which can be connected to every domestic premises, and then various appliances can be added without its being necessary to change the meter. As to the protection of steel mains against corrosion, Dr. Schütte mentioned, but did not describe, a new process he had seen at the Mannesmann Tube Works in Dusseldorf. In Bremen and also in Berlin, "Denso" bandage is employed.

Dr. Anderson, who followed, explained the difference between domestic and service governors in Germany.

New Processes for Gas-Works.

Then came the eagerly anticipated paper by Mr. A. L. Holton, Chief Engineer of the Manchester Corporation Gas Department, who described what—as far as concerns gas-works in this country—are two novel processes. The first is the semi-direct recovery of ammonia; the second the recovery of tar acids from ammoniacal liquor. Partington is the first typical gas-works to embody what for long has been the usual coke oven practice, and the difficulties encountered, and the solution of them, proved of absorbing interest. Partington is, of course, in a singular position in regard to effluent disposal; it is in a country district far removed from any sewage system. And this was the

ALFRED L. HOLTON.

Mr. Alfred L. Holton is a native of Sheffield, and commenced his career in the Industry in 1890 under Mr. Fletcher W. Stevenson, Engineer of the Sheffield United Gas Light Company. Commencing in the laboratory, he served in various capacities at each of their three works. During his term of service, the Grimesthorpe Gas-Works were erected and put to work, Mr. Holton being appointed Works Chemist and Manager of the Bye-Product Works in 1899. His next appointment was that of Manager of the Bye-Products Works of the Manchester Corporation in 1902, becoming Works Superintendent at the Bradford Road Gas-Works in 1914. From 1916 to 1922 the whole of the Bradford Road Gas-Works were entirely reconstructed and extended into a works capable of producing 23 million c.ft. per diem, and on completion Mr. Holton was appointed Manager. He was appointed to his present position of Chief Engineer to the Manchester Gas Department in 1928. Mr. Holton has always taken a very keen interest in the various professional associations connected with the Industry, and he inaugurated the Joint Junior Gas Associations' activities. He was the President of the Manchester and District Junior Gas Association in 1911.

68th Annual General Meeting of the Institution

A PHOTOGRAPH ON THE HORSE GUARDS PARADE.

deciding factor in the adoption of the semi-direct process, which results in a minimum amount of ammoniacal liquor for subsequent treatment. The whole of the plant was entrusted to W. C. Holmes & Co., Ltd., who contracted with the Bryan-Donkin Company, Ltd., for the turbo-exhausters.

The carbonizing plant at Partington consists of a 5 million a day Drakes horizontal installation and a Glover-West vertical plant of the same capacity, and the recovery plant is capable of dealing with the maximum make or any part of it. In the first instance the meters for measuring each stream of gas separately were of the ordinary rotary type. When, however, the plant was put into operation a new factor in gas-works practice became only too evident, for violent oscillations occurred which were communicated to all gauges on the gas stream. Satisfactory operation of the carbonizing plant was impossible under these conditions; and as a result of excessive oscillation, the readings of the rotary meters were naturally unreliable. Efforts were made to overcome this by finding a ratio between the rotary meters and the final "Connersville" meter, but all attempts proved unsuccessful. Since the final "Connersville" meter damped the oscillation, it was decided to substitute a "Connersville" for a rotary meter. This experiment solved completely the difficulty of oscillation from the retort house to the inlet of the meters, and a second "Connersville" meter was substituted for the other rotary meter. The oscillation on the outlet side still continues, but this is attended by no difficulties in the working of the plant.

The foregoing appears to have been the greatest problem, with the deposition of rock salt in the acid bath a good second. Contrary to expectations, however, tar gave practically no trouble in the saturator, only a trace being found after an extended run; and oxide purification has given no trouble due to the semi-direct process. There is, of course, a higher sulphuretted hydrogen than would be the case in the ordinary gas-works practice, the amount varying from 700 to 850 grains per 100 c.ft. As a result of the semi-direct process there is freedom from tar fog and oil deposits, which assists the process of purification.

Mr. Holton sets out valuable data in relation to normal working of the plant, and he gives a comparison between the semi-direct and indirect systems of ammonia recovery. This comparison shows that for a 10 million works there is a difference in capital expenditure of approximately £5000 in favour of the semi-direct process. In the case of a large works, the semi-direct system would have an added advantage to offer—*e.g.*, a 15 million works would require at least one additional washer-scrubber at £2500, while the increase in cost of a saturator to cope with 15 millions would differ but slightly from that of one of 10 million capacity. It is not improbable that the saturators installed at Partington would deal satisfactorily with a 50 p.ct. increase in gas load. In his summing-up, Mr. Holton says: "The plant at Partington is now working with every satisfaction, and it may justly be claimed that the semi-direct process is quite suitable and reliable for incorporation into ordinary gas-works practice. The salt produced is of good quality, being equal to most and better than many salts produced by the indirect process. The annual production amounts to 1900 tons, equivalent to 30·1 lbs. of sulphate of ammonia per ton of coal carbonized."

Dephenolation of Effluent Liquor.

The treatment of ammoniacal liquor to ensure a purified effluent is the subject of investigation, as our readers are well aware, by a Sub-Committee of the Institution; and it is interesting that the process adopted at Partington is largely the outcome of a careful study of the data set forth in the various communications of the Committee issued from time to time. After consideration of the various proposals for dealing with the effluent from the ammonia stills, it was finally decided to invite tenders for the erection of a dephenolating plant. A request was made by the Klär und Entphenolungs G.m.b.H., affiliated with Otto's Coke Ovens, Ltd., for samples to be forwarded for the purpose of examination with a view to ascertaining whether their process would be suitable. As a result of these investigations, and of subsequent negotiations, the Klär und Entphenolungs G.m.b.H. granted a licence to W. C. Holmes & Co., Ltd., for the right to erect, in England, plants embodying the process. A contract was then entered into by the Manchester Corporation with Messrs. Holmes for the erection of a plant embodying the Klär und Entphenolungs process, capable of dealing with a minimum of 20,000 and a maximum of 35,000 gallons of ammoniacal liquor per day, with a phenol content of 0·368 gramme per 100 c.c. The plant is now ready for operation.

A description of this plant, which is unique in this country, is given by Mr. Holton, and he explains the method of working. Oxygen absorption tests on the treated and untreated liquor showed a purification of 88 p.ct. Since the plant is only just completed, it is impossible for Mr. Holton to give actual working costs, but he anticipates that the income will cover all expenses incurred. The cost of the Partington plant will be about £6000, and it is estimated that the recovered phenols will yield an income of £1575. We are glad that Mr. Holton is to submit detailed working data, after the plant has been in operation, for publication by the Liquor Effluents and Ammonia Sub-Committee of the Institution.

Nature Intervenes.

Mr. H. D. Madden, of Cardiff, who was asked to open the discussion, regretted his inability to deal adequately with the paper, because during the previous week he had been a victim of circumstance—Nature, in unkind mood, having decided that 4½ in. of rain in two hours would be an amusing experience for the Cardiff Gas-Works. The real point of the paper to him is whether the cost of installing a semi-direct process is compensated for in the price obtained for the material made in the plant.

In Critical Mood.

The next speaker, Dr. E. W. Smith, was in a critical mood. "At the present time," he remarked, "it is difficult for any gas engineer to decide what is the proper thing to do with ammonia, and to tie oneself at this time to the extent of the capital necessary for a process limited entirely to one salt would not seem to me to be advisable." His point is that the paper cannot be a lead at the present time for gas engineers to go in for semi-direct recovery of ammonia. Dr. Smith said that there are three things to be borne in mind in the operation of semi-direct recovery—keep the tar out, and maintain gas at a correct and constant temperature, and the acidity of the bath constant over known periods. If this advice is followed, he suggests that variations in the amount of ammonia going to the bath do not matter. Another point is to ensure good circulation in the bath; and Dr. Smith pins his faith to high back-pressure in the saturator. At Partington the back-pressure is 15 in., whereas in what the speaker termed standard coke oven practice it is somewhere in the neighbourhood of 39 in. His view is that it is not necessary to work with more than one saturator, in spite of variations in load. Finally, Dr. Smith referred to the capital cost. The overall capital cost of semi-direct recovery, he maintains, should be lower than that of the indirect system, and in his experience the labour costs indicated by Mr. Holton are considerably higher than they ought to be.

A Tribute to Enterprise.

Dr. A. Parker admires the enterprise of Mr. Holton, and regards as of great value the author's description of his difficulties as well as of his successes. He regards the contribution as a good preliminary to a later paper. Dr. Parker expressed surprise at Dr. Smith's advocacy of such a high back-pressure in the saturator—his impression being that one could work at a lower pressure with the right design of cracker plate. As a result of the work on ammonia recovery he has done for the Institution, Dr. Parker has arrived at the conclusion that there is very little difference between the cost of manufacturing sulphate of ammonia by the indirect process, or by the direct or semi-direct systems.

Mr. D. M. Henshaw mentioned that the decision to install a semi-direct plant was made when the price of sulphate of ammonia was more than double the present figure,

though the question of the disposal of effluents was probably a more important point. As for the plant, it is almost identical in design with several installations of similar size which were erected in this country prior to the building of the Partington Works. It is, in fact, a well-known and established design. "Back-pressure," said Mr. Henshaw, "costs money, and, therefore, the lower the pressure at which the plant can be operated, the more efficient it may be regarded." And he called attention to the difference between coke-oven and gas-works practice, for the latter embodies oxide purification, which is responsible for additional back-pressure.

Congratulations on Mr. Holton's work were forthcoming from Mr. C. F. Botley, Chairman of the Ammonia Effluents Committee of the Institution, who said the Committee were greatly indebted to Mr. Holton, and looked forward to a greater co-operation with him in the general cause. Dr. A. C. Monkhouse also congratulated Mr. Holton, observing that his bold treatment of the difficulties which he encountered merits every success.

An interesting contribution to the discussion was made by Mr. W. B. McLusky, of Halifax, who suggested that the ammonia recovery plant at Partington would have caused less trouble had it been found practicable to keep the output of gas uniform from hour to hour. Reduced velocity of the gas through the cracker pipe in the saturator, he explained, was largely responsible for the formation of rock salt; and his remedy is a higher velocity of gas and a saturator of different design. "Our ultimate success," said Mr. McLusky, "will not be in the treatment of foul gas with clean acid." The discussion was then brought to a close; and the President asked for written contributions, one of which, by Mr. F. Firth, we are publishing in this issue.

New Officers of the Institution.

The result of the ballot for Officers, Auditors, Council, Hon. Members, Members, Associate Members, and Associates was at this stage announced:

President.—J. H. Canning, O.B.E., Newport, Mon.

Junior Vice-President.—F. P. Tarratt, Newcastle-on-Tyne.

Auditors.—A. E. Broadberry and A. Morland (Wood, Drew, & Co.).

Hon. Secretary.—W. E. Price.

Ordinary Members of Council.—Dr. E. W. Smith, Stephen Lacey, F. H. Jones, and Thomas Carmichael.

A list of the new members of the Institution will be found on a later page of this issue.

Mr. W. B. McLusky and Mr. R. H. Ruthven were elected to the Management Committee of the Benevolent Fund.

Mr. J. H. Canning expressed his grateful thanks for the honour of being elected President for the ensuing year.

District Members of Council.

The following were elected District Members of Council:

Eastern Counties Gas Managers' Association, A. Gregory (Harwich).
Irish Association of Gas Managers, G. Walmsley (Londonderry).
Manchester District Institution of Gas Engineers, W. J. Smith (Bolton).
Midland Association of Gas Engineers and Managers, H. J. Woodfine (Wellington).
North British Association of Gas Managers, T. W. Harper (Ayr).
North of England Gas Managers' Association, J. R. Bradshaw (Darlington).
Southern Association of Gas Engineers and Managers, H. C. Smith (London).
Wales and Monmouthshire Association of Gas Engineers and Managers, Octavius Thomas (Pentre).

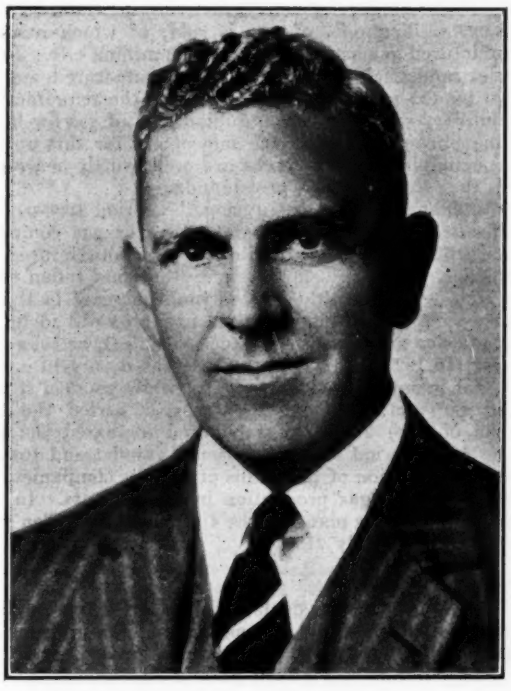
A World-Wide Organization.

At the First International Gas Conference on Wednesday morning the President's table was gay with the flags of twenty-one Nations, and there was an air of unusual interest. A full report of the proceedings appears on later pages, but we may mention that the President, having welcomed to the platform the delelgates from the various Nations, announced the formation, as a result of a meeting the previous evening, of the International Gas Union. Herr Fritz Escher, of Zurich, Past-President of the Swiss Gas and Water Society, was elected as first President, and Mr. Copp and Mr. Alexander were appointed as the two representatives of the Institution of Gas Engineers on the Council of the Union.

Mr. Copp then addressed the Conference, following which the new President of the International Gas Union spoke fluently in English, French, and German. He was followed by Major Alexander Forward, M. A. Baril, and Dr. Schütte, while Sir David Milne-Watson and Sir Francis Goodenough also spoke.

A Model of Co-Operation.

Mr. Clifford E. Paige, President of the American Gas Association, followed with an outline of the Gas Industry in America; and he impressed all his hearers with the magnitude and virility of the Industry in both the United States and Canada, and with the immense possibilities which lie before it. We have no hesitation in suggesting that these possibilities are the direct outcome of the method



CLIFFORD E. PAIGE.

Mr. Paige was born in Cleveland, Ohio, on May 2, 1884. He moved to Springfield, Mass., in 1885, left school in 1897, and worked in a grocery store from 1897 to 1899. He attended the Wesleyan Academy from 1899 to 1901, when he again sought employment in a grocery store and worked there until 1903. In 1903 he entered the employ of the Springfield Gas Light Company at Springfield, Mass., as an office boy, and was made an Assistant Superintendent in 1905. He then became Superintendent of the Malden and Melrose Gas Light Company at Malden, Mass., and became Manager of that company in 1912. In 1919 he was appointed Manager of the Worcester Gas Light Company, at Worcester, Mass. In 1922 he was elected Vice-President of Charles H. Tenney & Company, of Boston, Mass., and in addition to that position he became President of the Beverley Gas and Electric Company of Beverley, Mass. On Aug. 15, 1924, he became Vice-President of the Brooklyn Union Gas Company. He was President of New England Association of Gas Engineers in 1923; President, New England Association of Gas Managers in 1924; Director of the A.G.A. from 1923 to 1925; Treasurer of the A.G.A., 1926 to 1929; Vice-President, 1929 to 1930; and was elected President in October, 1930.

by which the Industry has tackled its problems. The success is due to co-operation of all branches within the Industry. To-day the A.G.A., which was founded in 1918, comprises the gas companies, the manufacturers of equipment and appliances, and individual members; its affairs are administered by an Executive Board which exercises exclusive jurisdiction over all affairs pertaining to its management, together with a permanent staff of specialists in every phase of the Industry. Said Mr. Paige: "The

representatives of all phases of the Industry's activities serve together on the appropriate Committees, and as a result this devoted interest to a common cause cannot fail to present a united front. Such a consummation is particularly valuable in our country, where we have carried specialization very far." It would be a good thing for everybody concerned if there was similar co-operation in the British Gas Industry.

There is nothing haphazard about the activities of the A.G.A., which works to a five-year programme, and which has as its *credo* " That there be continued adherence to the policy that the Association shall not extend its work beyond those objects which are of first importance and greatest practical value to the Industry, it being obvious that if its activities become broadened beyond the scope of practical accomplishment, its influence will inevitably be weakened." There is much in this belief. The A.G.A. is undoubtedly a model of co-operation.

American Statistics.

During the past ten years gas consumers in America have increased by 40 p.ct., and now number 16 million, 10,700,000 of whom are supplied with manufactured gas and the remainder with natural gas. During the same period, gas sales increased by 110 p.ct., due principally to the intensive development of existing markets. To-day 2,348,000 million c.ft. of gas is sold, of which quantity manufactured gas accounts for 408,000 million c.ft. In the decade, industrial consumption of manufactured gas has grown by 135 p.ct. In the year 1930, the manufactured gas industry sold over 25,000 million c.ft. of gas for house-heating purposes; in 1920 the sale of gas for this purpose was negligible. These facts are well worth bearing in mind; they are first-class propaganda.

As to changed conditions during the period 1920-30, it is significant that in 1920 carburetted water gas comprised 60 p.ct. of all the gas distributed by manufactured gas companies, while by 1930 the percentage had fallen to 37. This change has been due to the rapid increase in the use of coke oven gas, either produced in plants owned by gas companies or purchased from steel, chemical, or coke companies. In 1920 coke oven gas represented only 10 p.ct. of the total manufactured gas supply, while in 1930 it comprised 30 p.ct. During the ten-year period the total volume of coke oven gas distributed increased 382 p.ct. In the same period there has been a rapid trend towards the interconnection of the mains of various companies, and concentration of gas production in large plants. In 1919 there were 1300 gas plants in the United States. Ten years later there were only 715.

Research and Rates.

Two other matters dealt with by Mr. Paige ought to be emphasized—research and methods of charging for gas. Regarding the first, the work is not carried on in any one place, nor is it confined to any one agency or class of agencies. Fourteen institutions are now prosecuting research under A.G.A. direction, six universities, two Government Bureaux, and the private laboratories of six industrial concerns—all financed from the general funds of the Association except for projects in industrial gas utilization.

Then, in regard to rates, Mr. Paige refers to the trend towards the use of more rates—*i.e.*, different rates for different classes of service—the recognition of the service cost element in domestic rates, either through a service charge or a relatively high initial charge for the first few hundred cubic feet; and the establishment of the demand principle in industrial and house-heating charges. " Five years ago," he observes, " only 25 p.ct. of the domestic rates could be termed promotional or in any way based on sound theories of rate making practice, but to-day nearly 50 p.ct. of domestic rates embody some of the elements of fixed cost; this 50 p.ct. probably representing 80 p.ct. of the entire gas sold. In addition to this marked increase in the number of domestic rates reflecting the element of fixed cost, there have also been significant changes in the provisions regarding minimum bill. Five years ago nearly 10 p.ct. of the domestic rates had no minimum bill provision. However, to-day nearly 93 p.ct. of the domestic rates for gas service in America contain some sort of minimum bill provision."

A Model Representation.

Whether orators are born or made, Mr. Clifford Paige is unquestionably an orator of no mean order, and he held his audience spellbound by his spirited faith in gas and by his exceptionally interesting interpretation of how the Gas Industry in America is co-ordinating to face competition and effect rapid progress. When he had finished an outline of his paper—it was really more in the nature of a short address—there was prolonged and enthusiastic applause; and we heard from more than one part of the Hall the word which is surely the highest praise a speaker can get—" Encore."

The discussion on Mr. Paige's paper was opened by Mr. Copp. " I think," he said, " the organization of the American Gas Industry as set out in the paper is a model organization. I am not at all sure that we in this country have an organization which can compare with it. I refer to our District Associations and our Junior Associations; and I think that if we were to adopt something on the lines which are indicated by Mr. Paige, we might gain some advantage in our gas organizations in this country."

Sir Francis Goodenough followed, and characterized the author as " a man after our own hearts," and expressed the conference's great admiration of Mr. Paige and Major Forward and the staff of the American Gas Association for having presented so able a statement of the work of the Gas Industry as it exists in America to-day. He emphasized the virtue of planning research work over a period of years. " We in this country," he said, " are too much inclined to go on from day to day and from month to month and not look ahead and plan—not merely in the Gas Industry but in other industries. . . . As Mr. Paige said, preparation for the competition of to-day is one thing, but preparation for the competition of to-morrow and the future is another and still more important problem for us to tackle." Sir Francis Goodenough endorsed Mr. Paige's idea that it is of the greatest possible value to impress upon the public that gas is not stale simply because it has been used for so long; and in this respect he emphasized the psychological importance of the refrigeration load.

There were only two other speakers in the discussion—Mr. G. M. Gill and Mr. Walter T. Dunn—both of whom paid tribute to the wonderful manner in which Mr. Paige presented his paper. The former suggested that the best way to visualize the amazing progress in the sale of refrigerators during 1931 is that their capital value amounted to £1,000,000. Mr. Gill also gave a picture of the magnitude of the Gas Industry in the United States by his statement that last year 7½ times more therms were supplied in America in town supply than in the British Isles. Mr. Dunn made a fervent appeal for the Institution to " get busy " about a worthy home for a body of great importance to-day and which would be of still greater importance in the years to come.

The King's Birthday.

At the opening of the Session on Thursday morning, the President announced that on the previous day a telegram had been despatched to His Majesty the King on the occasion of his birthday, expressing the dutiful greetings and the congratulations of 1500 representatives from twenty-one countries overseas and the members of the Institution of Gas Engineers assembled in London. Mr. Copp read His Majesty's gracious reply.

Why Carbonize Ash?

On Thursday morning there were two papers, the first being by Dr. R. Lessing on a subject associated with his name—" Clean Coal in the Gas Industry." The paper is really a concise and most positive statement of the findings of a lifetime's investigation in the laboratory, on the semi-commercial scale, and, finally, in the commercial field itself; and we think that the author demonstrates that a rational improvement of the quality of coke is a practical proposition, and that it can be obtained not only without any addition to the cost of gas manufacture, but actually at a profit—and, of course, for the benefit of all concerned. Let us trace his argument.

In the first place, it is remarkable that scant attention has been paid to the raw material of gas manufacture and coke production—remarkable because of the wealth of im-

provement in the technique of gas and coke making. Refinement is everywhere evident except in the raw material, which is allowed to enter the retorts in a crude state, greatly to the detriment of every subsequent form of treatment and transformation. Prof. W. A. Bone said a few weeks ago that, had a tithe of the money expended on low-temperature carbonization been devoted to fundamental research upon coal and its industrial application, the country might not have been in its present unhappy predicament. And Dr. Lessing, though admitting that many gas undertakings are now buying their coal according to specification, maintains that the customary standards are, technically and economically, not of a high order. He maintains, too, that the remedy is at hand—clean coal. "Give the public a coke of minimum ash content," he says, "and the abatement of atmospheric pollution will take care of itself." We believe that such a coke, sold at the price of gas-works coke, is the only real solution to the nuisance caused by the domestic consumption of raw coal; and the solution would open up a tremendous market for the Gas Industry.

The average ash content of gas-works coke is now about 12 to 15 p.ct. In certain cases, 20 p.ct. is accepted with resignation. Yet it is known that the bulk of British coals have an inherent ash content of only 1·5 to 3 p.ct., equivalent to from 2·2 to 4·5 p.ct. of ash in the corresponding cokes. To "retort" the ash content of the coal supplied to British gas-works would require the equivalent of the carbonizing capacity of the Gas Light and Coke Company; and this "retorting" is done for the purpose of producing an inferior coke. Therefore, let us get down to the inherent ash content, and eliminate the extraneous ash. Dr. Lessing shows how this can be done commercially by the "Clean Coal" process which he has developed. This system has been fully described in the "JOURNAL," but it may not be out of place to refresh the memories of our readers as to its fundamental principles. First the natural dust (comprising nearly all the fusain and shale dust) is extracted from the coal pneumatically. The coal is then introduced into a solution of calcium chloride, whereupon the clean coal rises and the heavier refuse sinks. Both are then freed from adhering calcium chloride; and thanks to the fact that the clean coal does not contain dust, draining rates are obtainable which permit the calcium chloride to be completely extracted from a charge of 30 to 40 tons, and the water to be drained off, in less than two hours. The extraction and drainage are so thorough that the coal on discharge usually contains only about one-half the chloride percentage of the raw roal, and in the case of small slack or duff only 5 p.ct., or in nut sizes about 3 p.ct., of free moisture. Few coals contain more than 3 p.ct. of inherent ash, and typical Durham and Yorkshire gas coals usually yield a "clean coal" containing from 1·5 to 2·5 p.ct. of ash.

An Ideal Material for Carbonization.

Lucidly, Dr. Lessing explains why clean coal free from dust is an ideal material for carbonization, and, with reference to the tests which were carried out at the works of the Tottenham and District Gas Company, and which were the subject of one section of Mr. H. C. Smith's recent Presidential Address to the Southern Association of Gas Engineers and Managers, he quotes results of outstanding interest and value. In this investigation, the moisture percentage of the original coal (Yorkshire) was 4·27, and of the clean coal 4·34. As for the ash, this was reduced from 11·08 p.ct. to 1·66 p.ct. The clean coal was carbonized in Woodall-Duckham vertical retorts, and the resulting coke was compared with coke made from similar slack but which had not been cleaned. Much more large coke was produced by the clean coal and much less breeze, but the most remarkable result was the great reduction of ash in the sizes which are supplied as domestic fuel. For example, the grade ½ in. to 1¼ in. contained: Coke from uncleaned coal, 16·19 p.ct. ash; from cleaned coal, 3·18 p.ct. The clean coke is harder, slightly denser, and cleaner to the touch than that made from the raw coal, and is a more attractive fuel; it contains much less sulphur (the reduction being from 1·55 p.ct. to 0·96 p.ct.), a matter of great importance in domestic use; it is an ideal fuel for a domestic boiler; and it burns excellently in a coke burning grate.

But the benefits to the domestic consumer are not the only ones. The output of a carburetted water gas plant would be increased by at least 20 p.ct. by using the clean fuel, and the labour spent on clinkering would be largely reduced. And, of course, the gas-making capacity of coal gas plant would be greatly enhanced.

Does it Pay?

"There is," remarks Dr. Lessing, "a common idea abroad that on account of cost of cleaning operations and loss of tonnage, the use of truly clean coal for gas-works purposes is economically out of question." To illustrate the commercial aspect of the question, he has constructed an expenditure and revenue account based on the results of the Tottenham tests, and assuming that the coal is cleaned at the colliery. The significance of the account is that it shows a total expenditure, in the manufacture of gas equivalent to 72 therms, of 35s. 7·3d. in the case of uncleaned coal, against 33s. 10·5d. in the case of clean coal, or a saving of 2s. 2·3d. per ton of the former, although the uncleaned coal is probably of higher quality than the

R. LESSING, Ph.D.

Dr. Lessing was born on April 3, 1878, at Bamberg, Bavaria, and was educated at the Universities of Munich, Geneva, Berlin, and Manchester. He graduated in 1902 from A. von Beeyer's Laboratory at Munich University, and was subsequently private assistant to Prof. Willstaetter at Munich. In 1903 he held the Research Studentship at Owens College, Victoria University, Manchester, under Prof. W. H. Perkin, and from 1903 till 1906 he was Chief Research Chemist to the Gas Light and Coke Company, where he was mainly engaged on tar, ammonia, and cyanogen products from coal gas. From 1906 to 1907, Dr. Lessing was Chemist and Engineer to the Mond Nickel Company, in charge of the nickel carbonyl process, after which he established himself as Consulting Chemist and Chemical Engineer at Southampton House, 317, High Holborn, W.C. 1. He carried out industrial investigations mainly on coal and coal products, being the patentee of processes in connection with the working up of coal tar; neutralizing sulphate of ammonia; mining of coal by chemical means of contact rings; working up of coal tar without distillation; hydrogenation; de-dusting and cleaning of coal; and briquetting. Dr. Lessing introduced a number of standard methods into the field of coal research, such as the Lessing Carbonization Assay. He worked on the constitution of coal and particularly on the mineral constituents of coal, on the process of carbonization, and the cleaning of coal, publishing many papers in scientific and technical journals. In 1914, he delivered the William Young Memorial Lecture on the subject of "Catalysis in the Gas Industry;" and in 1925, Cantor Lectures on "Coal Ash and Clean Coal." He is Hon. Secretary and joint founder of the "Coal Research Club," and joint founder and Editor of "Fuel in Science and Practice." He gave evidence on "The Possibilities and Prospects of Developments in the Treatment of Coal" before the Royal Commission on the Coal Industry (1925). He is a member of the Committees on "Sampling and Analysis of Coal" of the Fuel Research Board, of the British Engineering Standards Association, of the London Section of the Society of Chemical Industry, a member of Council of the Institute of Fuel and the National Coal Smoke Abatement Society, and an honorary member of the Coke Oven Managers' Association; a Fellow of the Chemical Society and of the Institute of Fuel; and a member of the following Societies: American Chemical Society, Society of Chemical Industry, Faraday Society, Society of Public Analysts, Royal Society of Arts, Institution of Chemical Engineers, Institution of Gas Engineers, Institution of Mining Engineers, Institution of Petroleum Technologists, and Royal Institution. He has contributed a large number of papers in direct connection with gas meetings; and for one of these—"Carbonization in Chamber Settings"—which he read in 1909, he was awarded the Silver Medal of the Institution.

average kind used by the Industry to-day. The price of clean coke and breeze is assessed on the calorific basis, for " it seems hardly fair that the gas undertaking should pay a higher price for its coal, but should not obtain a corresponding increase for its coke."

However, on the assumption that the high-grade " clean " coke cannot be sold at a higher rate than the high-ash article, the revenue for clean coke and breeze was also calculated on a weight basis irrespective of quality —*i.e.*, at 24s. per ton for large coke and 7s. 6d. per ton of breeze. Even on this pessimistic basis, Dr. Lessing claims a saving of 1s. 1·6d. per ton. A statement is also set out comparing the cost per therm of carburetted water gas made from the two kinds of coke; and the following figures are given: With coke from uncleaned coal, 3·27d. per therm, against 3·024d. from clean coal.

More Money for Better Coke.

Opening the discussion, the President, having explained that Dr. Lessing had submitted his paper at his request, suggested that the author is inclined to be unduly optimistic when he says " Give the public a coke of minimum ash content, and the abatement of atmospheric pollution will take care of itself." " When we have anything to sell," he said, " we must tell the people what we have to sell and what it will do when we have sold it." We agree with this idea, but our conviction remains that the public would be willing to pay more for coke if once they learned to appreciate the superior qualities of smokeless fuel containing a minimum of ash. The consumers served by the Hull Station of the British Gas Light Company are singularly fortunate in that they receive gas-works coke with an ash content averaging, during the last six or seven years, 7·21 p.ct. Actually, since the beginning of 1928 the average ash content of the coke has been only 6·09 p.ct. This fact leads Mr. Copp to think that the washing and cleaning of coal are much better than Dr. Lessing suspects.

The next speaker was Sir Arthur Duckham, who expressed the view that the Gas Industry and the other fuel industries of Great Britain have not paid sufficient attention to the coal cleaning question, and that unless the coal industry adopts cleaning processes generally it will lose its markets abroad. In the Gas Industry, he maintains, coal cleaning must come, and it must come rapidly. Sir Arthur paid high tribute to the work of Dr. Lessing, and observed that the author had a process which would give as low an ash content as, if not one lower than, any other process in existence to-day. It is, in brief, an " absolute process." The only criticism which the speaker made was that Dr. Lessing rather gilds the lily. Mr. H. C. Smith, at whose works the tests outlined in the paper were carried out, said that there was no doubt that the preliminary treatment by de-dusting is largely responsible not only for the cleanliness and efficiency of the cleaning plant itself, but also for the cleanliness of the coal produced for carbonization; and he stressed the fact that in the coal treated at Tottenham the moisture content of the unclean coal was 4·27 p.ct., and this only increased to 4·34 p.ct. in the clean coal. He suggested, however, that the author's figure for the cost of cleaning coal is too low, and that his figure for the revenue obtainable from the dust is too high. Mr. Smith is also of the opinion that the credit which Dr. Lessing takes for lower costs of carbonization, and lower costs of maintenance and repairs, for clean coal requires modification.

Dr. E. W. Smith said that the Gas Industry as a whole will not have a smooth time until it is capable of producing consistently, from large works and small works, a coke which is as good as that available from the coking industry. At the same time sight should not be lost of the fact that during the last five years great progress has been made in the Gas Industry in the preparation and the production of coke. One of the important points brought out by Dr. Smith is that it is of no use for one or two large gas undertakings, either in London or the Provinces, to go to great expense to wash their coal and produce a good coke, if undertakings near by persist in manufacturing bad coke and spoiling the market. " One bad sale," observed Dr. Smith, " neutralizes a hundred good sales."

Dr. F. S. Sinnatt put in a strong plea for the coal industry, which, he said, is making a real endeavour to place at the disposal of the Gas Industry as much pure coal as can be obtained. In 1929 71 million tons, or 27 p.ct., of the total coal raised, was subjected to cleaning; and as only certain sizes of coal lend themselves to washing, this percentage might be nearly doubled when the amount of coal suitable for washing is taken into account. As our readers know, Dr. Sinnatt has been associated for many years with the Government survey of coal seams in this country; and he explained that it is possible to gain coal in the state of purity which Dr. Lessing is trying to obtain. The impurities associated with coal are not in the seams themselves, but are introduced afterwards. Mr. L. H. Sensicle suggested that in attempting to give a monetary expression to the advantages of clean coal, Dr. Lessing had put forward an insufficiently convincing case. Mr. Sensicle is a firm believer in the advantages of clean coal, but he thinks that to assess the financial values of cleaning, it is necessary to study the matter in much fuller detail. " I would suggest," concluded the speaker, " that, without troubling to express in figures the advantage of clean coal for gas making, an all-sufficient reason for its adoption should be the production of a clean coke which can compete successfully with other prepared fuels in the domestic market."

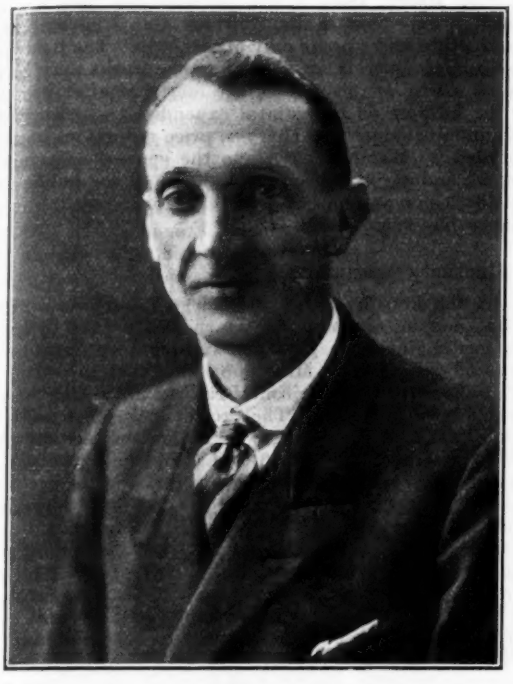
An interesting example of the result of clean coal on the coke sales of a small gas undertaking was cited by Mr. T. Law, of Malton, who remarked that he can get at least 3s. to 4s. per ton more for his coke produced from clean coal than if he used uncleaned coal. Mr. Law is the Engineer at an 85-million works, and he will not, in a general way, entertain any coal with more than 3 p.ct. of ash; and he is convinced that if the difference in cost between uncleaned and clean coal is as much as 2s per ton, it pays to use clean coal for its gas-producing qualities alone. " With modern plants," Mr. W. B. McLusky remarked, " it is less difficult than formerly to produce gas in any quantity, but without clean coal a gas plant will not do its best work, and it is an extravagant thing to waste good time and money on dirty coal." Clean coal and the adoption of blending constitute Mr. McLusky's recipe for a prosperous coke market. In his reply to the discussion Dr. Lessing referred to Mr. Copp's figures of the ash in his coke at Hull as being far from representing the average for the country. And as for gilding the lily, he is convinced that in a very few years what he has stated about the virtues of clean coal will be found to be true in fact. He does not agree with those who are of the opinion that they cannot get more money for clean coke than for coke of high ash content. " One fact is certain, that you will be able to sell every ounce of this better-class coke where the ordinary kind of coke will be a drug on the market."

Pressure Control in Gas Retorts.

The other paper on Thursday morning was by Mr. R. N. Webb, of the Leeds Corporation Gas Department, who asks whether all gas engineers are sure that they are using their exhausting machinery correctly. " We have all," he says, " experienced retort house difficulties that have eluded us, and which we have suffered as being inherent in the system, when, had we probed them, we should probably have found their cause. It is my opinion that the misuse of exhausting machinery, very often unknowingly, is the principal cause of these difficulties." And he proceeds to show how, by firm control at the New Wortley Gas-Works, great benefits were obtained.

At the outset, it should be mentioned that Mr. Webb has no retort house governors, and that the plant he deals with is an installation of horizontal retorts. During operation of the plant, there are periods when gas production is at a maximum, and then at a minimum; and the correct controlling of the revolutions of the exhausters to suit these conditions was the problem faced, and successfully overcome. The aim was simply to reproduce inside the exhauster governor-bell the pressure conditions prevailing in the common foul gas main in the retort house; and Mr. Webb is to be congratulated on the perseverance he exercised in bringing about eventually a satisfactory result. " Now," he remarks, " by the manipulation of very small weights on three or four occasions during a draw, we are able to maintain the pressure shown on the retort house register between zero and 0·4 of a tenth.

As to the benefits which have been obtained, these can be summarized as follows: Pores of the retorts filled with carbon, which prevents indrawing of furnace gases and loss of coal-gas, and additionally lengthens the life of the retorts; air not drawn in at mouthpieces; maximum quan-



R. N. WEBB.

Mr. R. N. Webb commenced at the New Wortley Gas-Works, Leeds, at the age of 16 years, under the late Mr. Robert Smith. From September, 1896, to April, 1904, he was trained by Mr. John Bond (now of Southport), who succeeded Mr. Smith, and in November, 1904, he was appointed Manager of the Works. The Works have a capacity of 8 million c.ft. per diem. Mr. Webb was President of the Yorkshire Junior Gas Association during the 1925-26 session. He was Lecturer of Gas Engineering at the Leeds Technical College from 1919 to 1929, and is at present a representative on the District Education Committee for the Yorkshire Area.

tity of gas produced; maximum quality of gas produced; quantity and quality of gas more regularly produced; stopped pipes reduced to a minimum and auguring made easy; length of time taken to do the draws reduced, with consequent lengthening of carbonizing periods and increased throughput of coal. Regarding the third benefit —*i.e.*, maximum quantity of gas produced—the make per ton has increased by 300 c.ft., due entirely to the better arrangements of control.

Why Not Use Retort House Governors?

Mr. Webb had insufficient time to complete his paper prior to the meeting, and his account of the pressure control system which he has in operation at Leeds was amplified by an addendum to his paper which will be published later in the "JOURNAL." The discussion was fairly short—the President, who opened it, remarking that he wondered why the author did not employ the ordinary method of using retort house governors. Mr. C. S. Shapley, who explained that the paper had been prepared at his behest, mentioned that the work was not yet completed, but he thought the subject was of such interest that the results so far obtained might well be put before the members.

Mr. B. R. Parkinson followed by suggesting that Mr. Webb is striving at an ideal of which he himself is not fully conscious, and he set out to try to prove that he is wrong; after which he endeavoured to prove that he is right. His remarks referred to ways and means rather than to results. A strange thing about the paper, said Mr. Parkinson, is the author's admission that the apparatus is not even now wholly automatic, periodical adjustments having to be made. Of great interest is the speaker's reference to an experiment which he is conducting in conjunction with the Gas Light and Coke Company in a scheme which combines the principles of the relay type of governor with that which utilizes its inlet pressure to work the valve.

This discussion concluded the proceedings on Thursday morning.

Council Luncheon to the President.

This private function took place at the Hotel Victoria on Thursday. The toast of "The President" was proposed by Mr. J. H. Canning and replied to by Mr. Copp; while the toast of "The President-Elect" was in the hands of Mr. H. D. Madden. Following Mr. Canning's response, the toast of "The Hon. Secretary and the Secretary" was proposed by Mr. Copp, and replied to by Mr. W. E. Price and Mr. J. R. W. Alexander.

An Improvement in Generosity.

Prior to the final technical session of the meeting, a General Meeting of the contributors to the Benevolent Fund of the Institution was held, with Mr. Copp in the chair. At this meeting, Mr. W. B. McLusky, of Halifax, and Mr. R. H. Ruthven, of Ramsgate, were elected members of the Committee of Management for the next three years in the places of Mr. W. H. Bennett, of Redhill, and Mr. G. S. Frith, of Runcorn. Proposing a vote of thanks to the Chairman, Committee, and Hon. Secretary, Mr. L. J. Langford, of Tunbridge Wells, referred particularly to the work of Mr. C. Valon Bennett, who, he said, has taken this great cause very much to heart. Mr. Bennett's work in connection with the appeal for funds last year resulted in an increase of over £123 in contributions to the Fund. Actual contributions received in 1930 totalled £729, compared with a total of £554 in 1929, and there are now about 50 p.ct. of the members of the Institution who subscribe. Mr. J. E. Blundell, in seconding the vote of thanks, said that we cannot rest content until this figure is increased to 100 p.ct. Mr. Blundell announced that that morning Mr. Frank Jones had given his third contribution of £100 to the Fund. The meeting terminated by the Chairman emphasizing that the question of subscription was not merely one of the amount subscribed.

One Complete Gas-Works.

The technical proceedings were brought to a close on Thursday afternoon by a paper by Mr. J. Herbert Clegg, in which the author gives a full account of the new Oswald

J. HERBERT CLEGG.

Mr. J. H. Clegg commenced his career 23 years ago with the Earby Gas Company, where he was instructed in the routine and management of a gas undertaking. He completed his training under agreement in gas engineering and management with the late Mr. A. Morton Fyffe, of the Nelson Corporation Gas Department, the whole occupying a period of six years. He was afterwards engaged with the Aldershot Gas, Water, and District Lighting Company for a period of two years, under Mr. R. W. Edwards, and left to take up the position of Second Assistant under Mr. A. Morton Fyffe again, who had by this time been appointed Engineer and General Manager of the Blackburn Corporation Gas Department, and later under Mr. J. W. McLusky, now of Glasgow. He was engaged at Blackburn for three years, and was in 1919 appointed Deputy Engineer and Manager under the late Mr. J. P. Leather, of the Burnley Corporation Gas-Works. Upon Mr. Leather's retirement seven years ago, he was appointed as his successor.

Street Gas-Works of the Burnley Corporation. This contribution will be of great value to any gas engineer contemplating extensions to his works, who will find the details of costs of erection and maintenance of the complete new plant at Burnley of the greatest assistance.

The preliminary layout of the new gas-works was submitted by the late Mr. J. P. Leather in 1923, who, at that time, was Engineer to the Burnley Corporation. With the exception of an alteration in the capacity of the installation, and a few minor amendments, the scheme was commended by Mr. Doig Gibb. Mr. Leather terminated his services with the Gas Department in 1924, and Mr. Clegg, who was appointed Engineer and Manager, was instructed to prepare a detailed scheme. He estimated the cost of the new works at £300,000.

Horizontal retorts were chosen as the carbonizing unit, for the site was extensive and the land not expensive; also the adoption of a Sulzer plant removed any objectionable steam from quenching, and the slight production of smoke in charging " is of no serious consequence." The type of setting is that of Messrs. Drakes, Ltd., equipped with their tubular regenerators. There are fourteen settings, seven of high-grade fireclay and the remainder of siliceous retorts. " These retorts," states Mr. Clegg, " were installed for comparative purposes, and to date there is no difference to be observed between them, either in the results produced or their condition." Congdon scrubber standpipes are employed, the installation being similar to the one erected at Stretford. When Mr. Clegg decided to install the Congdon pipes he felt that he would be fortunate if he did not experience some trouble, and was a little apprehensive regarding the possible cracking of the uptakes. However, such fears have not been realized in the slightest, and up to date no repairs have been necessary. The saving in labour and cleanliness in the retort house are unquestionable, and improved thermal yield has resulted. The dry coke produced is very popular.

No good purpose could be served by attempting to outline the plant in these columns, but an unusual feature is a Travers & Clark water gas plant, the only plant of its type to be erected, owing to the death of Mr. Clark before its completion. Messrs. Davison & Partner completed and started up the plant on behalf of the remaining Director of the firm. The plant is substantial, and generously constructed, and is capable of producing blue water gas to a quantity of not less than 750,000 c.ft. per 24 hours, or lightly carburetted water gas 775,000 c.ft., or 500 B.Th.U. gas 800,000 c.ft. per day. Any run can be either blue or carburetted at will, without loss of time for changing over. There are no hot valves, all the valves being on cool gas with consequent reduction in size and maintenance. The stack valves are of light weight and close by springs, and are therefore unusually tight. The levers, which are of the Westinghouse brake type, are grouped together for quick operation, and the manual labour required on the plant is therefore considerably lessened. To satisfy the variable demands made of the plant, the superheater is increased in capacity from the usual standard, but the carburettor, which is a separate vessel, although lined with firebrick is completely without chequer brickwork. The oil, being injected at high pressure, is finely atomized. The oil sprayer can be lifted out of the hot zone or easily removed for making blue water gas.

Results.

The new works were started up in November, 1927, and although 120 different contracts were let in the construction of the works, and 82 different contractors had been engaged whose work required " welding-in " to the adjoining contract, no hitch in the slightest degree was experienced—except that one conveyor ran in the reverse direction.

In 1928, Mr. Clegg reported the advisability of concentrating the production of the whole of the town's supply of gas at Oswald Street, and the closing-down of the works at Parker Lane, the cost of production at the old works being 9d. per 1000 c.ft. higher than at the new works. The latter were not of sufficient capacity to supply the whole requirements of the undertaking, and it was eventually decided to purchase 1½ million c.ft. of coke oven gas per day. New purifiers were installed at Oswald Street, and also a Humphreys & Glasgow carburetted water gas plant of a capacity of 1,350,000 c.ft. per day as a stand-by.

Up to March, 1930, it will be observed that a capital sum was expended in the Burnley Gas Undertaking on manufacture and storage only of £360,000. The bold policy of scrapping entirely an unsatisfactory works may be considered a wise one in view of the fact that after providing for the interest on the capital expended and after paying the annual sinking fund charges, price reductions had been conceded by March 31, 1930, to the general consumers of £38,457, industrial consumers £1357, and for public lighting £3206 per annum, whilst each year a substantial net balance has been available.

An Unusual Opportunity.

As the President said, Mr. Clegg is fortunate in that he has had an opportunity, which rarely falls to the lot of a gas engineer, to plan and complete an entirely new works on a new site. Mr. Copp noted that in setting out the disadvantages of horizontal retorts the author had not referred to labour costs. The President was also impressed by the fact that Mr. Clegg worked his combustion chambers at a temperature of 1375° C.; and he expressed surprise at the remarkable yield of over 75 therms per ton of coal carbonized in horizontal retorts. Concluding his remarks, Mr. Copp said: " I think Mr. Clegg is to be congratulated upon his very bold policy of scrapping plant with which he was not satisfied. The proof of the pudding is in the eating; after having done all this, he is enjoying the benefits of a completely new and most efficient plant, and his capital expenditure is only £347 per million c.ft."

The next speaker was Mr. R. E. Gibson, of Liverpool, who remarked that the full and detailed information given by Mr. Clegg with regard not only to the design and construction of the plant, but also to capital costs, working results, working costs, and maintenance charges, will be of the utmost value to members of the Institution. As one who has fought shy of the help of the Unemployment Grants Committee, he asked the author whether the conditions imposed by that Committee were such as to increase the capital cost beyond what it would have been if there had been no limitations. As many of our readers are aware, Mr. Gibson has a Sulzer plant of an improved and simplified design at his works. This plant has been working on a range of 96 retorts since the beginning of this year, and, said Mr. Gibson, it has worked very well indeed. It produces an excellent dry coke. Replying to the questions raised, Mr. Clegg remarked that labour costs represented only one item in the total cost of working a carbonizing installation, and that the maintenance costs of verticals, in his opinion, have proved to outweigh any disadvantage in regard to labour costs incurred in the working of horizontals. As to the high temperature of his combustion chambers, he assured the President that, after three years' working, both the chambers and the settings were in remarkably good condition. With regard to the high thermal yield of gas, he explained that, although he used slacks and dank, the coal is of good quality, has a fairly high volatile content, and is remarkably low in ash. Also the fact that the installation is new helps matters; and Mr. Clegg has no doubt of the beneficial results accruing from the Congdon standpipe system. Replying to Mr. Gibson's question, he said that a grant from the Unemployment Grants Committee is very acceptable, but the conditions imposed when the grant is obtained are in some cases onerous. But he has come to the definite conclusion that, where the installation is sufficiently large and particularly where the majority of the work is to be done by contract and not by direct labour, it undoubtedly pays to accept such a grant.

This concluded the technical business of the meeting.

Concluding Stages.

After the President had announced that the Research and Education Reports for 1930-31 will be presented at the Autumn Research Meeting on Oct. 27 and 28 next, Mr. J. H. Canning, the President-Elect, invited the Institution to hold its next annual meeting in London on June 7, 8, and 9, 1932—an invitation which was accepted with pleasure.

Then came a general vote of thanks to the representatives from Overseas, His Grace the Duke of Norfolk, Sir Joseph Petavel, K.B.E., F.R.S., D.Sc., Director of the National Physical Laboratory, Sir Arthur W. Hill, C.M.G., F.R.S., D.Sc., Director of the Royal Botanic Gardens, the Gas

Light and Coke Company; the Institution of Civil Engineers, those assisting in the arrangements for and the conduct of the Conference and Meeting, the authors of papers, the scrutineers of the ballots, the Officers, Auditors, Council, and Committees of the Institution, and the Secretary and Staff of the Institution.

This vote was entrusted to Sir Arthur Duckham, who spoke most graciously. He expressed the hope that in 1934, when the Second International Gas Conference will be held in Zurich, there will be a good attendance at that conference. "We have," he said, "been given sufficient notice, and there can be no excuse for not attending."

The vote was seconded by Mr. H. D. Madden; and the President, responding, mentioned particularly the services which had been rendered by the Secretary of the Institution and his Staff.

Mr. J. H. Canning: I am sure you will all agree with me that we cannot part without passing a very hearty vote of thanks to our President for a year of splendid work in the service of the Institution. I think it is a commonplace for proposers of this vote of thanks to say that only the Council know how much work falls to the lot of a President; I would go even further, and would say that only the Secretary and the Honorary Secretary realize fully how much the President does for this Institution. The past year will be a memorable one in the history of the Institution. . . . During the year your President has attended the meetings of the Belgian Gas Engineers, the French Gas Congress in Paris, and has spent a good deal of time as your representative at the World Power Conference. But I think the outstanding achievement of the year, and one with which our President's name will always be connected, is the holding of this first International Gas Conference. We have made a beginning, and I feel that this movement will have very great consequences for the Gas Industry throughout the world in the future, and will result in very great advantages to us. It is a great thing that we should be able to combine in this way internationally, and I am quite sure that it will redound to the prestige and prosperity of the Gas Industry.

J. H. CANNING.

Mr. J. Herbert Canning, who succeeds Mr. Harold E. Copp in the presidential chair of the Institution of Gas Engineers, has been Engineer and Manager of the Newport (Monmouthshire) Gas Company since 1919, being the eldest son of the late Mr. Thomas Canning, who was Engineer and Manager of the same works for many years before him until his death in 1919. Mr. J. H. Canning was educated at Prior Park College, Bath, and subsequently studied engineering and science at the Technical College, Newport, where he was particularly successful. He was silver medallist in science in 1893 and gold medallist for the best record in science over the three years 1892 to 1895. In 1897 he was successful in gaining the first prize in the honours class, and the national silver medal awarded in connection with the examinations of the City and Guilds of London Institute. He has twice been President of the Wales and Monmouthshire District Institution of Gas Engineers and Managers—in 1910 and 1920—and it is of interest to note that his father was the first President of that Institution. In 1915 he was appointed by the High Explosives Committee to organize and direct the work of providing high explosives in Wales and Monmouthshire, and was assisted by a committee of five gas engineers. He was appointed divisional officer (coke and gas) for the same area in 1918. He was made an Officer of the Order of the British Empire in 1920 for war services. Mr. Canning is Chairman of the South Wales District Committee of the Federation of Gas Employers and also of the South Wales Regional Gas Industrial Council.

Now we come to the termination of the very wonderful meeting we have held here, and for which our President has been so largely responsible; but I do feel, and I am certain you will agree with me, that in returning thanks we should couple with the name of the President that of Mrs. Copp. ["Hear, hear," and Applause.] Not only has Mrs. Copp done a great deal to assist the President during his year of office, but, by acting as our hostess on Tuesday and as hostess to the overseas representatives last night, she has done very much to ensure the success of this meeting.

Our President will very soon be joining that select and distinguished band of Past-Presidents, who form, I may say with confidence, not the least asset of this Institution. Their knowledge and their ripe experience are always available to the Council, and have proved of great advantage in the past, as I am sure they will do in the future. I am quite certain, Mr. President, that although your term of office as President is coming to an end, you will continue to render to us useful service.

In conclusion, I should like to present to you on behalf of the Institution, the Certificate commemorating your year of Office, coupled with the wish that you and Mrs. Copp may enjoy good health and happiness, and that all good fortune may attend you.

The Certificate was presented, amid applause.

The President, in the course of his response, said: I feel rather at a loss to express to you all that I have in my mind, and if I fail to do so I hope you will pardon me. I have felt no undue elation or satisfaction directly in occupying this very honourable position as President of the Institution of Gas Engineers, except so far as it has given me an opportunity of serving the interests of the Industry and the Institution, and therein I confess myself to be very proud. But a President cannot go very far, no matter what his abilities or characteristics may be, without support, and I should like to place on record my very deep appreciation of the kindness which I have received from every member. . . . I hope still to be able to render further service to the Gas Industry. I am very glad and gratified to note that the interest in our proceedings has been maintained right to the end of the meeting, and that so many members are present at this the last session, when much of the business is more or less of a formal character. That there should be unflagging support right to the end of the meeting constitutes one of the greatest compliments you could pay to a President.

I should like to express my gratitude to the gentlemen representing the Press, who have been exceedingly kind to me. We have every reason to be very proud of the Press, which records so faithfully the activities of the Gas Industry.

Sir John Ferguson Bell and Sir Henry Wade Deacon.

The President: I suppose you are all aware that two gentlemen connected very closely with the Gas Industry—Mr. J. Ferguson Bell and Mr. Henry Wade Deacon—have been honoured by the King, who has bestowed Knighthoods upon them. Sir John Ferguson Bell is a Past-President of the Institution, and Sir Henry Wade Deacon is the Chairman of the Liverpool Gas Company, of which our Senior Vice-President is the Chief Official. On your behalf I have sent to Sir John and Sir Henry messages of congratulations, and I have received telegrams from them, expressing their thanks.

A memorable meeting then closed.

The Institution Benevolent Fund

The General Meeting of the contributors to the Benevolent Fund of the Institution of Gas Engineers was held in the Great Hall of the Institution of Civil Engineers, Great George Street, Westminster, S.W. 1, on Thursday, June 4, 1931—Mr. HAROLD E. COPP (the President of the Institution) in the Chair.

The HON. SECRETARY (Mr. J. R. W. Alexander) read the notice convening the meeting; and the minutes of the previous general meeting, held on June 5, 1930, were read, confirmed, and signed.

The CHAIRMAN then moved:

> That the Report of the Committee of Management for 1930-31, and the Accounts for 1930, which have been printed and circulated amongst the contributors, be taken as read, and adopted.

Mr. T. F. CANNING (Southend-on-Sea): I have pleasure in seconding that.

The resolution was carried.

The report stated that the Fund has an increasing and beneficent sphere of usefulness towards members in straitened circumstances, and the widows, children, and dependents of deceased members, seventeen of whom received assistance from the Fund in 1930.

The total amount expended in grants was £595 9s., as compared with £540 in 14 grants in 1929. Visitors, appointed by the Committee, call upon each recipient at intervals and report as to the circumstances of the person receiving assistance and if the case is being dealt with satisfactorily. The expenses of the Fund have been confined as usual to the necessary outlay for printing, stationery, and postage.

Contributions received in 1930 totalled £729 17s. 6d., being £495 13s. in subscriptions and £234 4s. 6d. in donations, as compared with a total of £554 8s. 5d. in 1929. £123 15s. of the increase resulted from the special appeal made by Mr. C. Valon Bennett in 1930, to whom the cordial thanks of the Committee are due.

The administration of the Fund and the basis upon which grants are made have been entirely re-organized, and special invitations to Members of the Institution have been issued in 1931 with a view to increasing the number of subscribers to the Fund, which in 1930 totalled 720, as compared with 518 in 1929. The membership of the Institution is 1444.

The Committee of Management express its gratitude to all contributors to the Fund, and is particularly appreciative of the continued support of the District Associations and certain anonymous contributors.

REPORT OF SCRUTINEERS.

The HON. SECRETARY: The Scrutineers of the ballot report that Mr. W. B. McLusky (Halifax) and Mr. R. H. Ruthven (Ramsgate) have been elected members of the Committee of Management for the ensuing three years, in the places of Mr. W. H. Bennett (Redhill) and Mr. G. S. Frith (Runcorn), who retire in accordance with the regulations.

VOTE OF THANKS TO CHAIRMAN, COMMITTEE, AND HON. SECRETARY.

Mr. L. J. LANGFORD (Tunbridge Wells): It is my privilege to propose a vote of thanks to the Chairman, the Committee of Management, and the Hon. Secretary of the Benevolent Fund. I do this in no formal manner, because very great enthusiasm has been displayed by the Committee in this great work. I should like to refer particularly to the work of Mr. C. Valon Bennett. [Applause.] Mr. Valon Bennett has taken this great cause very much to heart, because he is one of those good gentlemen who are always looking out to help any of their brother professionals who are in distressed circumstances. I know that he was very, very disappointed—though I do not think he ought to have been—with the result of his efforts when he sent personal letters to the whole of the members of the Institution who were not subscribers to this Fund. The result was in many ways satisfactory, but, as I say, to him it was disappointing. I think this great work will go on. We have about 50 p.ct. of the members of the Institution subscribing to the Fund. I suppose that that is a very good percentage, but we are a big Chartered Institution, and we really want to make this Fund the success it should be. We are not yet in that strong position we want to occupy, and we do hope that those who have not yet subscribed will remember that it is not yet too late, and that they will remember the letter which Mr. Valon Bennett sent to them. I know that he will be only too delighted to hear from them.

I have very great pleasure in moving a vote of thanks to the Chairman, the Committee of Management, and the Hon. Secretary of the Benevolent Fund.

Mr. J. E. BLUNDELL (Carlisle): I have much pleasure in seconding the proposition that has been put by Mr. Langford. I feel that, to say anything about the Benevolent Fund to those present to-day is rather like preaching to the converted. The people who have taken the trouble to be here are the people who subscribe, and I think it is a great pity that we cannot, or do not, make reference to our Benevolent Fund when the hall is full. I think it is due to oversight or neglect that some members of the Institution do not contribute to a Fund from which they may be pleased, some day, to take something. People come to us with recommendations, and we do our best; we are most anxious that no one should suffer. Every case is inquired into very carefully, but we cannot do all that we want to do, for lack of funds. If you who do subscribe will mention this matter in your own districts and try to persuade others to subscribe and to take an active part in this great movement, you will have done a service to the Gas Industry and to your colleagues.

The Hon. Secretary informs me, and I am sure you will be pleased to know, that Mr. Frank Jones has this morning given his third contribution of £100 to the Fund.* [Applause.]

I wish that my friend Mr. Valon Bennett had been asked to second this resolution. None other than those who are on the Committee, working with him, know what a great amount of work he put into his appeal, and, while Mr. Langford seems to think that he ought to have been satisfied with the response, I personally feel, as Mr. Valon Bennett does, that there should have been a 100 p.ct. response, and that the people who did not take the trouble to reply to his letter ought at least to be told about it. We are very anxious that this Fund should do good work, but we are crippled for want of subscriptions. Try to help us and make our job a pleasant one.

The vote of thanks was carried with acclamation.

There being no further business,

The CHAIRMAN said: I should like to emphasize that this is not only a very valuable movement, but that it is one which involves the credit of the Institution. It is not merely a question of the amount subscribed; what I feel about it is that the proportion of subscribers relatively to the number of members of the Institution should be increased. Every case is scrutinized very carefully, as the seconder of the proposal has mentioned, and in respect of some of the cases which come before us we feel that we should like to be a good deal more generous than we have been able to be. I do appeal to you who are subscribers to use your influence with those who are not subscribing, so that a larger proportion of the members of the Institution will become active subscribers to our excellent Benevolent Fund.

The meeting then closed.

* Mr. Jones has promised £500 altogether.

First International Gas Conference

LONDON: JUNE 3, 1931

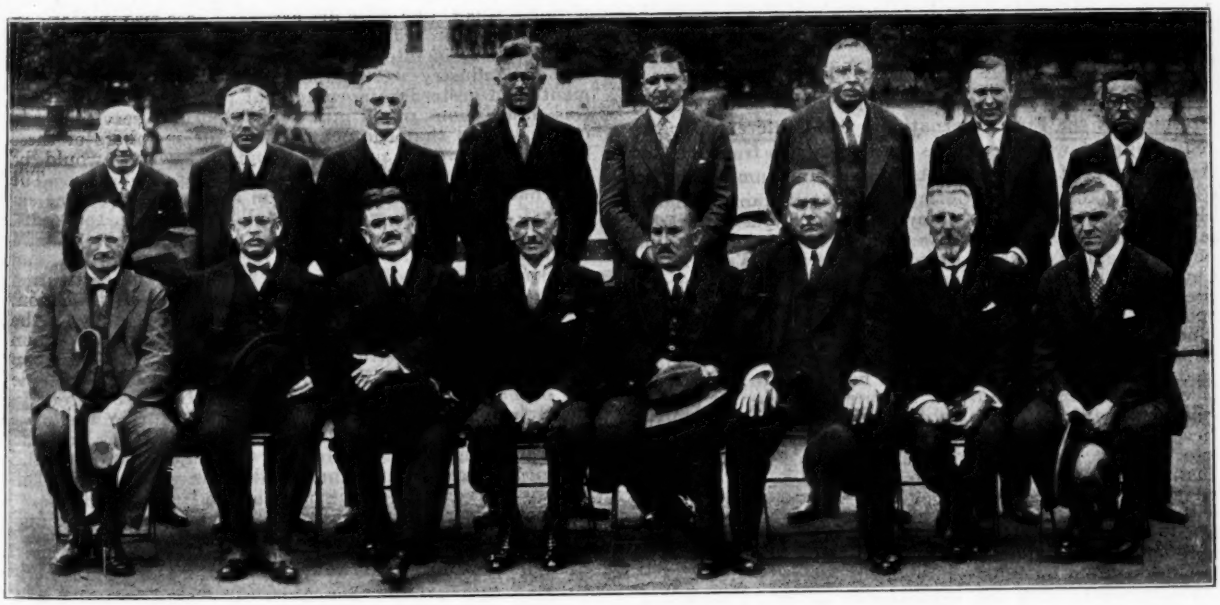
JUNE 3, 1931, will be a red-letter day in the annals of the Gas Industry of every nation, for it witnessed the First International Gas Conference—the Inaugural Meeting of the International Gas Union, whose conception and inception is chronicled in the ensuing report. Herr Dipl. Ing. Fritz Escher, of Zurich, is the first President of the Union; and as the office is for a three-year term, it is he who will welcome the Second Conference to his home city in 1934. Mr. Harold E. Copp and Mr. J. R. W. Alexander are the British representatives on the Council of the Union; and Mr. Copp presided at the first Conference.

The Conference assembled at 10 a.m. at the Institution of Civil Engineers, Great George Street, Westminster.

Mr. J. R. W. ALEXANDER having announced that greetings had been received from the Gas Associations of Denmark, Greece, Italy, Poland, and Spain, Mr. H. E. COPP welcomed the overseas delegates on the platform.

OVERSEAS DELEGATES.

Mr. Clifford E. Paige (New York, President of the American Gas Association); Major Alexander Forward (New York, Managing Director of the American Gas Association); and Mr. Henry F. Gibb (Washington Gas Light Company) represented America. Sir Arthur Duckham represented Australia; Mon. H. de le Paulle (Brussels, Past-President, Association des Gaziers Belges) represented Belgium. Mr. Harold Greig (Assistant Works Manager to the Tramway, Light, and Power Company of Rio de Janeiro); and Mr. W. T. W. Pilbeam (Assistant General Manager of the City of Santos Improvement Company) represented Brazil. Mr. J. W. Brown (Engineer



COUNCILLORS OF THE INTERNATIONAL GAS UNION.

Front Row, Left to Right—G. H. HULTMAN (Stockholm), H. SCHÜTTE (Bremen), A. BARIL (Paris), H. E. COPP (Hull), F. ESCHER (Zurich), P. de LACHOMETTE (Paris), H. de le PAULLE (Brussels), C. E. PAIGE (New York).

Back Row, Left to Right—W. E. PRICE (Hon. Sec. Inst.Gas E.), G. A. BRENDER à BRANDIS (The Hague), ALEX. FORWARD (New York), G. E. H. ZOLLIKOFER (Zurich), P. ε MOUGIN (Paris), K. LEMPELIUS (Berlin), J. R. W. ALEXANDER (London), H. MORIOKA (Kobe).

and General Manager of the Barbados Gas Company, Ltd.), British West Indies. Mr. F. J. West, of Manchester, represented Canada. Mr. S. Barker Johnson (Engineer and Manager of the Colombo Gas and Water Company, Ltd.), Ceylon. M. de Hanislav Landa (Lecturer of Fuel Technology at the Czech Polytechnical High School of Prague) Czechoslovakia. M. A. Baril (Paris, Past-President, Association Technique de l'Industrie du Gaz en France); M. O. Guillet (Besancon, Vice-President, Association Technique de l'Industrie du Gaz en France; M. P. de Lachomette (Paris, Vice-President, Union Syndicale de l'Industrie du Gaz en France); and M. P. Mougin (Paris, General Secretary, Union Syndicale de l'Industrie du Gaz en France) represented France. Dr. H. Schütte (Bremen, Immediate Past-President, Deutscher Verein von Gas- und Wasserfachmännern, E.V.); and Dr. Karl Lempelius (Berlin, Managing Director, Deutscher Verein von Gas- und Wasserfachmännern, E.V.) represented Germany. Mr. J. Rutten (The Hague, President, Vereeniging van Gasfabrikanten in Nederland) and Prof. G. A. Brender à Brandis (The Hague, Professor at the Technical University, Delft, Vereeniging van Gasfabrikanten in Nederland) represented Holland. Mr. Gyozo Schon (Budapest, Chief Gas-Works Director, Magyar Gasyarak Orszagos Szovetsege), Hungary. Mr. H. Morioka (Kobe, Engineer of the Kobe Gas Company, Japanese Imperial Gas Association), Japan. Mr. A. E. Buckley (Engineer and General Manager of the Malta and Mediterranean Gas Company), Malta. Mr. John Irminger (Bergen, Immediate Past-President, Norske Gasverkers Forening), Norway. Mr. H. M. Tysoe (Engineer and Manager of the City of Johannesburg Gas Department), South Africa. Mr. G. H. Hultman (Stockholm, President, Svenska Gasverksforeningen), Sweden. Herr Fritz Escher (Zurich, President, Union Internationale de l'Industrie du Gaz, Past-President, Société Suisse de l'Industrie du Gaz et des Eaux) and Lt.-Col. G. E. H. Zollikofer (Zurich, Secretary, Société Suisse de l'Industrie du Gaz et des Eaux) represented Switzerland. Mr. Rudolf Vrbanic (Zagreb, President, Yugoslavensko Plinaresko I Vodovodno Udruzenje), Yugoslavia. Mr. John N. Whyte (Chief Engineer and General Manager of the Montevideo Gas and Dock Company), Uruguay; and Mr. W. H. Cattell, of Birmingham, the New Zealand Gas Institute.

A Welcome from the President.

Mr. Copp: It is my pleasure and privilege, as the elected President of the First International Gas Conference, to extend a sincere welcome to the representatives from the Gas Associations of America, Australia, Belgium, Canada, Czechoslovakia, France, Germany, Great Britain, Holland, Hungary, Japan, Norway, New Zealand, Sweden, Switzerland, and Yugoslavia, and to members of the Institution of Gas Engineers present from Brazil, British West Indies, Ceylon, Malta, South Africa, and Uruguay. We much appreciate the enthusiastic manner in which they have responded to the invitation of the Institution of Gas Engineers that the First International Gas Conference should be held in London at this time. We are mindful of the fact that many of those from overseas have had to travel considerable distances. Such a gesture typifies the cordial relationship which animates gas engineers of all nationalities, who had a common origin, a century and a quarter ago, in that great gas engineer, William Murdoch. The Institution of Gas Engineers are privileged to be your hosts on this occasion, and we hope that your visit to London will be both instructive and enjoyable. If by our efforts the Institution contributes something towards the furtherance of the Gas Industry in any part of the world, our labours will not have been in vain.

Concurrently with the organization of this Conference, negotiations have proceeded, on the initiation of the French Gas Association, for the formation of an International Gas Union, and I am pleased to say that a spirit of mutual understanding and co-operation has resulted in the formation of such a body, the Statutes of which were approved by the National Representatives at the First Council Meeting of the International Gas Union in the Council Chamber of the Institution last night. Herr Fritz Escher, of Zurich, a Past President of the Swiss Gas and Water Society, was elected the first President; and the Gas Associations of Belgium, France, Germany, and Great Britain were invited to nominate Vice-Presidents. The Institution of Gas Engineers is the member of the International Gas Union on behalf of Great Britain, and the Council have appointed Mr. J. R. W. Alexander and myself as its two representatives on the Council of the Union, which has further honoured the Institution by electing me a Vice-President for the ensuing three years. The International Gas Union will consist of the Gas Associations of the different nations, each of which will be entitled to nominate two members on the Council. The President remains in office for three years, and has power to fix the headquarters of the Union and appoint a General Secretary. In addition to providing a centre for the acquisition, collation, and distribution of technical and other information concerning the gas industry and the promotion of its well-being generally, the Union will hold conferences at intervals of three years, the organization of which will be undertaken by the Gas Association of the nation in whose country the Conference is to be held.

The inauguration of the Union is an important development, and likely to lead to extremely beneficial results. Our thanks are due to Herr Escher and the French Gas Association for the diligence with which they have pursued this matter during the past few months, and we ought to acknowledge our indebtedness to the Secretary of the Institution of Gas Engineers for the capable negotiations conducted by him in the interests of Great Britain. Further particulars of the International Gas Union will be made available in due course, and I will not, therefore, describe its objects further, but merely extend to the Union the cordial goodwill of us all for its future prosperity and success.

The President also greeted the delegates in French and German.

Herr Fritz Escher: I would like to express my best thanks to you, Mr. President, and the Institution of Gas Engineers for the invitation to the First International Gas Conference, held in conjunction with your 68th Annual General Meeting in London, which has been extended to all Overseas Gas Associations, and especially on behalf of the Swiss Society of Gas Engineers of which I am one of the representatives here. I also thank you for the honour you have paid me in electing me as President of the International Gas Union, for the honour you have paid to our country, to our Gas Organization, to my town, and to myself. It was in October last year that the Institution of Gas Engineers invited all overseas gas organizations to the First International Gas Conference. In the meantime, the Union Syndicale de l'Industrie du Gaz en France invited those Associations to a meeting to be held in Paris on Nov. 25, 1930, at which the Statutes of the International Gas Union were discussed. Those two invitations, sent to all gas organizations, proved clearly that the idea and necessity of international contact and collaboration in the gas industry were imperative. Mr. Thomas Hardie mentioned yesterday morning that the collaboration of all Gas Associations would give very important service to the industry, and that contact between the members of these associations would produce friendships which would be valuable in the development of the Gas Industry. The International Gas Union will form a bond between gas engineers all over the world, and allow problems to be discussed which are of interest to them all. In conclusion, I again offer you our best thanks for your co-operation, and my personal thanks for the great assistance the Institution of Gas Engineers has given to the formation of the Union. I wish also to thank the President and the Secretary of the Institution who have so actively helped to form the Union and to remove difficulties which have arisen. As Mr. Copp has pointed out, the President of the Union has to decide the seat of the Union and nominate the General Secretary, and I have the honour to tell you that during the next three years the seat of the Union shall be Paris and the General Secretary M. P. Mougin, General Secretary of the Union Syndicale de l'Industrie du Gaz en France. The headquarters will be at the office of the Union Syndicale.

Herr Escher then repeated his remarks in French and German.

Major Alexander Forward (Managing Director, American Gas Association): The American Gas Association can be more ably and technically represented by our President, Mr. Paige, and will be so represented on your programme later, but it remains for me to express our appreciation of the opportunity of attending your meeting and partaking of your hospitality. Over here we can see many things and hear many things that are new to us, and we can perhaps enjoy some things that we cannot enjoy in our own country. [Laughter.] It is a very great pleasure to us to receive visits from time to time from members of your organization and of others abroad, and we are always glad to see them at the American Gas Association offices and to

do anything in our power to help them in presenting such information and contacts as they may desire. We learn a great deal from them, and we are happy to have them come and see us. Therefore, in a sense we are now returning a party call in being over here at this time. Moreover, the members of our organization and those who are active in the Gas Industry in the United States and in the Dominion of Canada are always so thoroughly well taken care of when they come to this side, that it is a pleasure indeed to make this public acknowledgment of the fact. Several of your members who are resident on our side have particularly desired me to give you their regards, and best wishes. One of those men is J. B. Klumpp, a former President of the American Gas Association. He lives in Philadelphia and has been a member of your Institution since 1907. Another is Mr. Gordon King, a member of my staff, as Service Engineer at the American Gas Association headquarters. He joined the Institution as soon as he was eligible as a student member in 1905. Another is my friend Mr. Egner. Mr. Egner wrote to me on May 20, from his home in our capital city, Washington, where he is in retirement at the age, I believe, of 85. Mr. Egner sends me a printed programme of a meeting of the Evening Star Lodge of Freemasons on May 1, 1902, in connection with the Annual Meeting of the Institution of Gas Engineers. He was introduced, he says, by the late Walter King, Publisher and Editor of the "Journal of Gas Lighting," of Bolt Court, Fleet Street. Sir George Livesey was one of the leaders of the Gas Institution then. Some of those, says Mr. Egner, whom he knew over here are now with the great majority.

I thank you again for the opportunity to give you this brief message from America, to express our pleasure at being here, and to say that we shall be delighted to see any of you at any time at our headquarters in Lexington Avenue, New York.

Sir DAVID MILNE-WATSON: It is a great pleasure to me to be here this morning at your first International gathering. Science, as we all know, is international. It knows no country and has no boundaries, and therefore I am sure it is an excellent thing that the Gas Industry should unite in working on scientific lines internationally. It is indeed a great pleasure to me, therefore, to see so many representatives from foreign countries here to-day, who have come from all parts of the world on this most interesting occasion. There are innumerable problems to be solved in the Gas Industry. We have a very long history behind us, going back to over 120 years, a long and exceedingly honourable history; but still, while we have done great things in the past as an industry, there are still greater things lying in front of us to do. As I say, in these matters of scientific development, it is all-important that the scientific knowledge of the world, to whatever industry one belongs, should be pooled and made available for all. Therefore, it is a very important thing and a good step that the Institution of Gas Engineers has united with other scientific bodies in this work. We in the Gas Industry in this country are very proud of being the first home of the gas industry, and we have watched the expansion of the industry over Europe and over all the world. Thank you very much indeed for giving me an opportunity of making these few remarks.

M. A. BARIL (Past-President, Association Technique), speaking in French, said: I am indeed flattered that the honour has fallen to me to-day of conveying to you all, and especially to the Institution of Gas Engineers, at the first meeting of the International Gas Union, the cordial greetings of the various French Organizations grouped under the ægis of the Union Syndicale. May I say a word or two of the past, and express my confidence in the future?

It was in September, 1929, that I proposed to our President, M. Ellissen, that at the next meeting of the Union Syndicale the possibilities of founding an International Union should be discussed. My suggestion was well received; a Committee was nominated and drew up a code; then in August, 1930, with the strong encouragement of our then President, M. Georges Vautier, I undertook to carry on further with the realization of our project. I therefore got into touch with several of our influential colleagues, among them M. Böhm (Italy), de le Paulle (Belgium), Fritz Escher (Switzerland), T. Keclik (Czecho Slovakia), Rezola (Spain), H. Schütte (Germany), and F. Eliot Williams (England). All expressed their sympathy with our proposals; and I should like to-day to pay a public tribute to the valuable support so freely given me. I should also like to take this opportunity of thanking very sincerely, on behalf of my friends and colleagues, the gas men of all the countries, and especially Herr Escher, who were good enough, in response to the invitation given them, to come over to Paris in November and again in May to place the seal on our constitution.

As for the future, I only want to say a few words as to the motives which have actuated us, and the objective which we have set up. We firmly believe that frequent meetings with our colleagues, and the pooling of information on all questions affecting our Industry, must make for progress. For example, in the field of coal utilization, or more precisely in the art of bringing cheaply into the consumers' houses the heat of that coal in its varied and more pleasant forms, all gas men take pride in the fact that their processes have continuously improved since the inception of the Industry. Yet they believe that, thanks to the uninterrupted progress of science, these methods can be and should be brought to even greater perfection, and that in this direction stretches a wide field open for their activity and that of their successors. The duty of avoiding, in the interest of generations to come, the too rapid exhaustion of the world's coal supply is recognized not merely by an enlightened minority. It is impressed upon the minds of all, and more especially upon us of the Gas Industry. We realize, as Mr. Lloyd George very rightly claimed in a speech at the London Opera House in 1915, that "coal is our very life blood. In peace coal is the most important factor in the industrial life of a country. The blood which circulates in the veins of our national industries is distilled coal." But conservation of material is not enough; we have also to give special attention to social questions. Not one from among us will deny that our duty lies in continuous research for the bettering of working conditions, of the hygiene of our workshops and offices, and in the furtherance of "safety first" methods. Thinking along another line, we share a common determination to assure a just return upon the capital invested in our undertakings; and in this regard, I may perhaps recall that the capital of gas undertakings rests in the hands of an ever-growing number of small investors who merit all the more attention in that they have given us their wider confidence.

To sum up, I am firmly convinced that gas men, to whatever nation they belong, fully realize the extent and the complexity of the problems which confront them, and are conscious of their high calling. All are appreciative of the advantages to be gained from collaboration in its widest sense—that is to say, conceived on an international scale. Not one but realizes that in contributing his share to the edifice which we are building, he will be working for the eventual betterment of his fellows and the good of mankind.

For the realization of these ideals, I convey the sincerest good wishes of French gas men on the natal day of the International Gas Union; accept them, I beg you, mon cher President, as they are offered, with a very full heart.

Dr. H. SCHUTTE (Bremen) speaking (in German) for the German Gas and Water Association, of which he is immediate Past-President, and also for the Swedish Association, thanked the President for his welcome. When the proposal for the formation of an International Gas Union had been put by M. Baril before the German Association, they had, said Dr. Schütte, agreed without hesitation to do all within their power towards the success of the new body. They hoped that it might be to some extent the means of promoting a better understanding between all nations, and in this sense it would have their hearty support.

ZURICH, 1934.

Herr F. ESCHER: The Statutes of the International Gas Union stipulate that the International Congresses shall be held in the country of the President, and shall be organized by the Gas Organization of which the President is a member. I therefore have the honour to invite you to the Second International Gas Congress in Zurich to be held in 1934. I offer you that invitation in the name of the Swiss Association of Gas and Water Engineers and in the name of the Town Council of Zurich.

The PRESIDENT: I am sure we are very gratified to receive this very kind invitation from Herr Escher, and although the date of the next Conference is in the somewhat distant future, I hope that the Institution of Gas Engineers will very cordially respond to that kind invitation.

Sir FRANCIS GOODENOUGH, called upon by the President, said: I had no warning whatever that I was to be asked to speak at this moment. I would only like to say on behalf

THE COUNCIL OF THE INSTITUTION AND THE

of the British Commercial Gas Association how glad we are to associate ourselves with any movement which makes for international goodwill and co-operation. I do not know enough of the proposals with regard to the International Gas Union to express any views upon them this morning, but I would like to say, as I have just mentioned, that any movement which makes for international co-operation, the spread of knowledge, and the interchange of opinions upon matters of scientific and technical interest—which as Sir David Milne-Watson has said are to-day of universal application and value—has my warmest sympathy, and I am sure I can say on behalf of the B.C.G.A. that we shall wish it every success.

This brought the business meeting of the Union to a close, and the Conference returned to the agenda of the Institution Meeting.

The President's Dinner to the Council and Overseas Delegates

On the Wednesday evening a distinguished gathering of representatives of gas at home and abroad were entertained to dinner at Grosvenor House, Park Lane. Among those not executively connected with the Industry were the Rt. Hon. Viscount Mersey, C.M.G. (a Director of the British Gas Light Company), Sir Richard Glazebrook, K.C.B., F.R.S. (Chief Gas Examiner), Lt.-Cdr. the Hon. J. M. Kenworthy, R.N., M.P., Lt.-Col. E. Kitson Clark, T.D., M.A. (President of the Institution of Mechanical Engineers), and Mr. J. F. Ronca, O.B.E. (Director of Gas Administration).

After the Loyal Toast had been honoured,

The PRESIDENT said: To-day I caused a telegram to be sent to His Majesty the King on the occasion of his birthday. It was in the following terms:

> "1500 representatives from 21 countries overseas and members of the Institution of Gas Engineers assembled in London at the First International Gas Conference and the 68th Annual General Meeting of the Institution of Gas Engineers send dutiful greetings and loyal congratulations on the occasion of your Majesty's birthday.—H. E. COPP, President."

His Majesty has graciously sent the following reply:

> "The King sincerely thanks the members of the Institution of Gas Engineers and the representatives from overseas assembled at the First International Gas Conference for their kind and loyal congratulations on His Majesty's birthday."

The PRESIDENT, proposing the toast of "Our Guests," said: This is an occasion of great historical importance in the history of the Gas Industry and also of the Institution of Gas Engineers inasmuch as it marks the consummation of a series of efforts, which have always been conducted in a most amicable and friendly spirit, to draw together the representatives of other nations of the world. I am very thankful to know that such consummation is almost, if not entirely, completed to-night. We are delighted to see all the representatives from overseas here, and I am sure that the seeds of friendship that have been sown will lead to very appropriate fruit in due time. The international friendships and relations which have been promoted during these negotiations can only lead to a better understanding between the nations of the world. I submit that the confusion of tongues has been nothing more or less than a world nuisance, because if we could have understood one another and could have conveyed our mutual thoughts and sympathies, the family party of the whole world would have been very much happier than it is to-day. I cannot help thinking that the business of the world to-day is getting far too complicated, and that we have too many typewriters in relation to the number of artisans that we employ. I feel that if we were to simplify our business methods and get down to hard tacks and the real facts of life, we should get on very much better both nationally and internationally.

I do not want to say too much about our friends from foreign countries who have honoured us with their presence to-night. I have already stated during the meetings of the Institution how delighted we are to welcome them here, and I do hope and believe that having met them and having associated with them as we have during the past few days, our friendship with them will be cemented.

The toast was honoured with enthusiasm.

The PRESIDENT: I am now going to ask you to rise and drink what is perhaps a rather unusual toast, but this is a very appropriate occasion for it. It is the toast of our "Absent Colleagues."

The toast was drunk in silence.

THE HOME OF THE GAS INDUSTRY.

Herr FRITZ ESCHER (Switzerland): It is a great honour and a very great pleasure to be allowed to reply to this toast and to thank you again. You heard this morning from your President what has been done in the matter of the International Gas Union. You have also heard this evening that the International Gas Union will make friendships between the representatives of the nations of the world. I think the birth of the International Gas Union is a very happy event, and I regard it as a happy omen that the First International Congress has been held in London, because I feel the Union has been born under a lucky star. The art of gas making has been developed not only in England, but also in Belgium, France, Germany, and in other countries; but the Industry was founded in England.

HE OVERSEAS REPRESENTATIVES.

It is exactly 125 years ago that William Murdoch, as we learned in school, illuminated the mechanical shop of Boulton & Watt to celebrate the peace of Amiens. As to the International Gas Union, I say that its future is so bright and its influence will be so powerful that the Gas Industry throughout the world will benefit considerably. England is the home of the Gas Industry, and it is a country where for a long time our engineers have come to learn. I am pleased to say that my father and my grandfather came over to England to learn the mechanical arts, and I am glad that it has been possible for me to come to England several times. I began my practice as a gas engineer with the Continental Union Gas Company which has headquarters in Paris and London, and I am glad to feel that my start in life in the Gas Industry was with an English Company.

The Truest Brotherhood.

Mr. Clifford E. Paige (America): I need not tell you that we feel it a privilege and an honour to be here. This is an impressive occasion to me, to find that when I go back to my country I can report that we have had a marvellous meeting of your Association and that I have been privileged to meet so many people from so many parts of the world. I have already said that we have looked to England for inspiration not for years but for generations; and perhaps the most impressive event in indicating the closeness of our bond occurred a year ago last October when the convention of the American Gas Association which was being held in Atlantic City, New Jersey, was addressed by radio from London by Sir David Milne-Watson. It may be of some interest to you to know that his remarks came to us so clearly that it seemed to us almost from another world; but as he went on we realized that he not only spoke our own language, but he covered our own problems just as if he had been sitting in council with us. That, to me, indicates the similarity of our problems as gas people. We have a wonderful asset in our organization, whether it be national or international. In this respect we are not a competitive people, at least with each other, and consequently we may gather round the festive board or we may meet in convention and we do not have to withhold things from each other because they happen to be our stock-in-trade. Consequently, we may go forward in the truest conception of brotherhood developing our businesses and meeting the problems which will always be before us.

Dr. H. Schutte (Germany): It is a very great honour to attend this excellent gathering this year, and we have all enjoyed it. This is the third time I have had the good fortune to come to the Annual Meeting of the Institution of Gas Engineers, and I am always very heartily welcomed and received so hospitably that I do not know how we shall be able to make up for it in any way. I feel confident that the First International Gas Congress will further the interests of our Industry and contribute to the welfare of mankind throughout the world. I drink to your very good health and to the prosperity of the Institution of Gas Engineers.

M. A. Baril (France): In the name of the French delegates I have the great honour of expressing to our colleagues of the Institution of Gas Engineers, and especially to their President, Mr. Harold Copp, our kindly thanks for their amiable reception. We shall leave London, to which we are always happy to return, with lasting memories. This is the first meeting of the International Union, and I am certain that at the next meeting in Zurich, to which our President, Herr Escher, has invited us in 1934, we shall have even a larger attendance and that the close collaboration which has taken place on this occasion will by then have borne fruit.

M. G. H. Hultman (Sweden): Sweden is a small country, and, as you know, we take our gas knowledge from the bigger nations, especially England and Germany. We benefit from your experience, although we claim to make some small contribution. Last winter, for instance, in Stockholm we made a very interesting test at the State Laboratory in order to ascertain with continuous instruments the efficiency of a coke-fired boiler for central heating; and we found as an average during the whole season that the figure was 83·4 p.ct. We are now prepared to make similar tests on coal-fired and oil-fired boilers. May I express most hearty thanks on behalf of myself and Mr. Irminger, of the Norwegian Gas Association, and say that I do so with very keen regard for the whole of the Gas Industry in England, for your skilful managers, and for your excellent gas journals.

"The President and Council of the Institution."

M. H. de le Paulle (Belgium): I wish to express to the President and members of the Institution of Gas Engineers our gratitude for their kind reception. It is at the same time an honour and a pleasure—an honour because we wish to say to the Big Sister of our different Associations how proud we are to be able to benefit from her great experience in the Gas Industry, and a pleasure because we appreciate passing a few days in the cordial atmosphere which is so characteristic of English hospitality. Our satisfaction at being so received and welcomed is all the greater when we think that to-day we have been attending the birth of a child, and let me say at once how proud we are to see that the child is quite healthy. Great care has been taken in the choice of its parents [laughter], who realize their duties and obligations so well defined this morning by Mr. Copp, Herr Escher, Dr. Schütte, and M. Baril. The child is born under the best conditions. It is now the duty of us all to watch over the education of the new-born organism so that it may be instructed in the best qualities of the Associations in the various countries.

Mr. J. H. Canning (President-Elect), responding to the toast, said: I feel it is a great honour that is paid to me in being asked to respond to the toast which has been so ably proposed by M. de le Paulle. I should like in the first place to thank him for the way in which he has proposed the toast and to tell him that we appreciate very much indeed the kindliness of his expressions of goodwill and of sympathy towards us. I should also like to take this opportunity of thanking the speakers from overseas this evening who have done us the courtesy of addressing us in our own language, and to tell them how much we appreciate that courtesy. I may say that the child of which M. de le Paulle has spoken has been long anticipated [laughter], and, in addition to that, it has had the advantage, which so many children do not have, of choosing its own parents, so I think we can sincerely hope that it will grow up to be a very vigorous and virile man. There has been, as you know, a traditional friendship between this Institution and kindred Institutions all over the world. It has existed as long as most of us remember, but it has been informal. Nothing definite has come of it, but I think we may congratulate ourselves to-day upon achieving a formal agreement with our friends in all parts of the world, an agreement which will lead to the interchange of technical and other information which must benefit and strengthen the Gas Industry all over the globe. There is another advantage, I think, in an International Association of this kind. I do not want to depreciate the League of Nations, which is doing so much to promote international peace; but the League of Nations after all is for the most part composed of statesmen, and when statesmen smile upon each other and talk complacently to each other, they all begin to wonder what the other man has got at the back of his head. I think, therefore, that international friendship and international peace are fostered far more by associations of this kind, where all the members

have the same end in view, where all our interests are identical, and where a man can smile on his friend and talk to his friend without that friend having the idea that he has an *arrière pensée* at the back of it. I believe that if our industries could meet together internationally we could go a long way towards achieving that understanding which is the only means, in my opinion, of achieving international peace.

"THE CHAIRMAN."

Sir DAVID MILNE-WATSON: I feel you would not like to separate to-night without drinking the health of our Chairman. We in the Gas Industry all feel that Mr. Copp has carried out his duties to-night in a most admirable manner, as he has, indeed, the whole of the duties of the meetings that have been held in London during this week. He has not been in very good health, and therefore it must have been a considerable strain upon him. We hope he will long be spared to occupy the important position which he now holds in the Gas Industry and in his Company.

The Toast was drunk enthusiastically, and accorded musical honours.

The PRESIDENT, replying, said: I must confess that I am almost overwhelmed with the cordiality of your reception and your very kind expression of goodwill towards myself. I think this is a memorable occasion and one which will have a lasting effect on the whole of the Gas Industry, not only in this country but in every other country. We hope that the child of whom we have heard so much will grow up to maturity under proper parental authority.

"Auld Lang Syne," and the company broke up; the majority to take part in the "London by Night" tour.

New Members of the Institution

On the Tuesday afternoon, the following were elected to Honorary Membership, Membership, Associate Membership, and Associateship of the Institution:

HONORARY MEMBERSHIP.

The President (*ex officio*) of the Union Internationale de l'Industrie du Gaz and of the Gas Associations of America, Australia, Belgium, Canada, Czechoslovakia, Denmark, France, Germany, Greece, Holland, Hungary, Italy, Japan, New Zealand, Norway, Spain, Sweden, Switzerland, and Yugoslavia.

MEMBERSHIP.

Blakeley, William, Managing Director, Firth Blakeley, Sons, & Co., Ltd., Vulcan Ironworks, Church Fenton, Leeds.

Bowater, Norman James, O.B.E., B.Sc., Engineer and Director of Chamber Ovens, Ltd., and Gas Chambers and Coke Ovens, Ltd., Artillery House, Westminster, S.W. 1.

Easson, William Scott, Engineer and Manager, Gas-Works, Selkirk.

Jackson, George James, Managing Director, Woodall-Duckham Vertical Retort and Oven Construction Company (1920), Ltd., 136, Victoria Street, S.W. 1.

King, Edward James, Joint Managing Director, Robert Dempster & Sons, Ltd., Elland, Yorks.

Macfarlane, Alfred Anderson, Institution Diplomé in Gas Engineering, 1st Class, 1929, Technical Assistant, Provan Gas-Works of the Glasgow Corporation.

Richards, Francis Bartlett, M.B.E., Managing Director, Arthur Duckham & Co. (1920), Ltd., 136, Victoria Street, S.W. 1.

Saville, Herbert, Chairman and Managing Director of F. C. Sugden & Co., Ltd., Leeds.

Wedgwood, Philip, B.Sc., Institution Diplomé in Gas Engineering, 2nd Class, 1929, Works Chemist, Bankside Station of the South Metropolitan Gas Company.

West, John Frederick, M.A., Assistant General Manager, West's Gas Improvement Company, Ltd., Manchester.

West, Frank, Chairman and Managing Director, Derbyshire Silica Firebrick Company, Ltd., Friden.

ASSOCIATE MEMBERSHIP.

Agent, Lionel Saxby, Technical Assistant, Sydenham Works of the South Suburban Gas Company.

Allerton, Harry, Technical Assistant, Garston Works of the Liverpool Gas Company.

Borrett, Victor James, Assistant Works Manager, Trowbridge Gas-Works.

Cottrell, Albert Frederick, Operating Engineer, Woodall-Duckham Vertical Retort and Oven Construction Company (1920), Ltd., 136, Victoria Street, S.W. 1.

Dyde, John Horsfall, M.Sc., Technical Assistant, Plymouth and Stonehouse Gas Light and Coke Company.

Elliott, George Herbert, Engineer, Broadhead Constructions, Ltd., Stretford, Manchester.

Madden, Terence Henderson, Engineering Assistant, Cardiff Gas Light and Coke Company.

Mogford, Graham Alexander, Engineering Assistant, Cardiff Gas Light and Coke Company.

Nichols, James Allen, Assistant Resident Engineer, Bromley-by-Bow Station of the Gas Light and Coke Company.

Pye, James William, General Works Assistant, Plymouth and Stonehouse Gas Company.

Rea, Alexander Cochrane, Technical Assistant, Edinburgh Corporation Gas Department.

Shadbolt, John Hurst, Resident Erection Engineer, West's Gas Improvement Company, Ltd., Manchester.

Small, Howard D., Assistant Engineer and Manager, Maidstone Gas Company.

Staniforth, Fred, Manager, South Yorkshire and Derbyshire Gas Company, Whitwell.

Storrier, James, Chief Draughtsman and Technical Assistant, Dundee Corporation Gas Department.

Tildesley, William Robert David, Assistant Engineer and Manager, Tamworth Gas Company.

Wardle, Noel Frederick Darlington, Technical Assistant, Bath Gas Company.

ASSOCIATESHIP.

Franks, Geoffrey Charles Reynell, Distribution Engineer, Gas Department of the Municipality of Singapore, Straits Settlement.

Gilbert, Albert Thomas, Technical Expert, Willey & Co., Ltd., Exeter.

Hilham, Reginald William, Distribution Superintendent, Chichester Gas Company.

Lornie, David Christie, Distribution Engineer, Colombo Gas and Water Company, Ltd., Ceylon.

Parsons, Charles John, Assistant Engineer and Distribution Superintendent, Leominster Gas and Coke Company, Ltd.

Phillips, George Cuthbert Davidson, Gas Engineer, Samuel Cutler & Sons, Ltd., 39, Victoria Street, S.W. 1.

Restall, Reginald James, Engineering Assistant, Burnley Gas Department.

SOCIAL EVENTS

MRS. COPP AS HOSTESS.

The lot of the Lady President of the Institution Meeting seems to become more strenuous as the years roll by; but in proportion as her work as hostess increases, so does the enjoyment gained by the hundreds of ladies who now attend the annual "festival." Mrs. Harold Copp earned the gratitude and the congratulations of all for the large part she played in last week's programme.

Mrs. Copp was "at home" at the Hyde Park Hotel on the Tuesday afternoon from 4 to 6 p.m., and three hours later was at her husband's side welcoming the army of guests at the reception and dance at the Park Lane Hotel. There were nearly 300 acceptances for her afternoon party, and over 1000 for the reception. In the afternoon Mrs. Copp carried a charming bouquet of tea roses presented to her by Miss Patricia Smith, daughter of Mr. Harold Smith, President of the Southern Association, on behalf of that Association; in the evening an elegant spray of pale pink

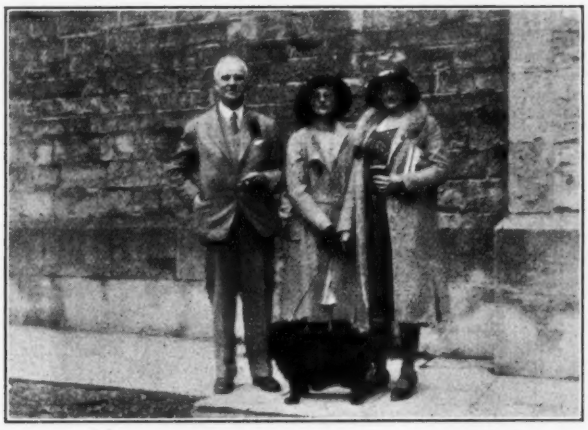
MRS. COPP.

carnations and lilies was the gift of the Midland Association, and presented by Mrs. Arthur Roberts, wife of their Secretary.

On the Wednesday evening Mrs. Copp entertained the ladies from overseas to dinner at the Park Lane Hotel, and afterwards took them to join the "London by Night" tour.

ONE OF LONDON'S GREAT SIGHTS.

The "London by Night" motor tour was one of the items which might well be repeated on a future occasion, when members should be urged to bring along some of their electrically-minded councillors. There will be reproduced in our next issue some photographs of London's magnificent gas street lighting installations, but well as the pictures may be printed, they can convey to only a limited extent the efficiency of the lighting. To those who had not previously seen these thoroughfares under conditions of artificial lighting, the tour was a revelation. This we know from comments which reached our ears. London's street gas lighting deserves the widest possible recognition, and we hope that appreciation of it will be encouraged.



For the benefit of any resolved to further this appreciation, it will be helpful to append the route taken during last Wednesday's tour. It does not include all the excellent gas lighting that is to be seen, but it contains sufficient to convince any unprejudiced person that gas is unsurpassed for street lighting, as it is for so many other purposes. Here, then, is the route: Waterloo Place, Trafalgar Square, Whitehall, Parliament Square, Victoria Street, Vauxhall Bridge Road, Vauxhall Bridge, Harleyford Road, Kennington Gate, Brixton Road, Vassall Road, Camberwell New Road, Peckham Road, Queen's Road, New Cross Road, Blackheath Road, Lewisham Road, Loampit Hill, Lewisham High Road, Old Kent Road, New Kent Road, Elephant and Castle, Blackfriars Road, Blackfriars Bridge, Queen Victoria Street, Cannon Street, St. Paul's Churchyard, Ludgate Hill, Fleet Street, Strand, Kingsway, New Oxford Street, High Street St. Giles, Tottenham Court

Road, Marylebone Road, Cambridge Terrace, Bayswater Road, Marble Arch, Oxford Street, Oxford Circus, Regent Street, Piccadilly Circus, Lower Regent Street, Waterloo Place, Pall Mall, Charing Cross, Westminster, and Victoria.

SCENES OF BEAUTY THAT IMPRESSED.

On Wednesday afternoon, a large party of ladies left Westminster Pier on the steam launch " His Majesty " for the Royal Botanic Gardens at Kew, which, bathed in brilliant sunshine, were radiantly beautiful. On arrival the visitors were (in the unavoidable absence of the Director, Sir Arthur W. Hill, C.M.G., F.R.S., D.Sc.) received by the Deputy-Director, who gave them a short address on the history of the gardens. Thereafter they were formed into groups, for an inspection of as many of the houses as it was possible to see in the time at disposal. At no season could the 300 acres of grounds containing every species of tree, shrub, and flower, have looked more lovely than they did that day.

An Afternoon at Windsor.

Some of our friends from Overseas were among the party at Kew, as was also the case on the Thursday afternoon, when the visit was to Windsor. Here, too, good fortune attended the outing; for the weather was again brilliant, and the town of Windsor was seen in festive garb, on the occasion of the Fourth of June celebrations at Eton. The journey to Windsor was made in luxurious motor coaches, and the outward and return routes selected revealed many of the principal beauties of a beautiful part of the country. The drive on the way home through Windsor Great Park, and alongside Ascot Racecourse to Virginia Water may, perhaps, be specially singled out in this connection.

When the 200 or more visitors reached Windsor, they were greeted by Mr. J. G. Abbott, who succeeded the late Mr. H. Buckley as Engineer and Manager of the Windsor Royal Gas Light Company, and a move was at once made to the world-famed Castle, nearly a mile in circumference, which was founded by William the Conqueror, and has since that far-away time been constantly extended and altered.

St. George's Chapel was the first spot visited, where were seen the stalls and banners of the Knights of the Garter. From the North Terrace a striking view was obtained of neighbouring Eton, with its historic five-hundred year old College. Unfortunately the State Apartments were closed, consequent upon the near approach of Royal Ascot Race Meeting, but a visit to the Royal Stables and Riding School proved of great interest.

THE SUSSEX TOUR.

But pleasant as had been the afternoons of Wednesday and Thursday, it was, of course, to Friday that thoughts were mainly turned and in connection with which anticipation was keenest. The Sussex Tour provided the greatest test of the organizing ability that was behind all the arrangements, and in no respect did the test show failure. One expected to find at the platform of Victoria Station the special train which was to convey the party of more than two hundred (again happily including some Overseas visitors) to Brighton; it is by the smaller things that organization is finally judged, and in these directions, too, nothing was lacking. One appreciated, for example, the idea of providing each traveller with a fine specimen of the red Old English Clove.

Brighton.

When Brighton was reached, Mr. C. H. Rutter, M.Inst.C.E., Engineer and General Manager of the Brighton and Hove Gas Company, with many members of his staff, was waiting at the station to welcome the visitors, who had an hour or so to spend on the sea-front for which Brighton is so justly famed, and which they saw under almost ideal conditions. Later they met again at the Hotel Metropole, where about two hundred and fifty sat down to lunch. It was a big party, but not too big to be accommodated by the Hotel Metropole management, whose catering was excellent.

Well-Deserved Tributes.

The speech-making, also, was of a pleasing nature, for it provided recognition of the efforts of those who had worked hard to make the business meetings and the social events so eminently successful. The toast of " The Mayor and Corporation of the County Borough of Brighton," which was proposed in felicitous terms by the President (Mr. H. E. Copp), was responded to by Mr. James H. Rothwell, C.B.E., the Town Clerk, who remarked upon the fact that the Institution embraces both private and municipal enterprise. " I know," continued the Town Clerk, " no two better examples of private enterprise and municipal enter-

prise than the Brighton and Hove Gas Company on the one hand, and the Corporation Electricity Undertaking on the other. The Gas Company have recently extended their responsibilities by taking into their area the Borough of Worthing, and this makes the undertaking a much bigger one. It looks, therefore, as though the destiny of a great part of the South Coast, so far as gas is concerned, will remain in the hands of the Brighton Gas Company."

In submitting "The Institution of Gas Engineers," Alderman Fred. J. West, C.B.E., J.P., M.Inst.C.E., was afforded an opportunity of making those acknowledgments which all present felt to be due. "I should like," he said, "to express our grateful appreciation of the able manner in which Mr. Copp has conducted the affairs of the Institution during the whole year, and particularly during the present conference. [Applause.] It has been an epoch-making conference. It has brought together the largest and most representative gathering of the Gas Industry that I think has ever been known. Never before have so many friends from Overseas attended our meeting and sat down at our social board. We are delighted to have them with us. Mr. Copp can look back with a tremendous amount of satisfaction to his year of office. And of the Incoming President, Mr. J. H. Canning, we would say that he takes over a virile and loyal Institution. He has behind him an excellent Council. He has, in Mr. Alexander and his staff, officials of whom any Institution might be proud. The whole of the arrangements for this conference have been excellent. [Applause.] Above all, the Incoming President has behind him an Industry which is flourishing, and which will continue to flourish."

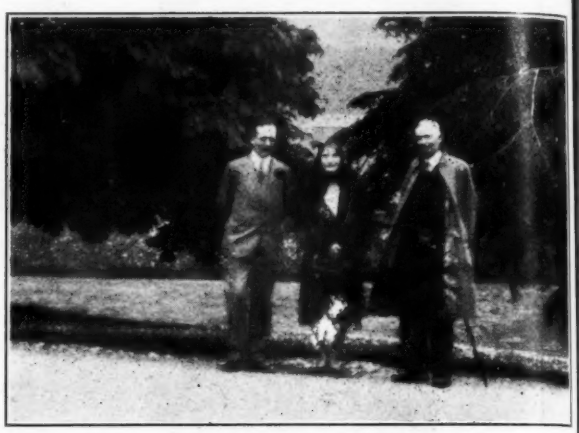
Responding, Mr. J. H. Canning, O.B.E., added to the tribute paid by Alderman West to the President, by saying that no one could have carried out the duties better or in a more dignified manner than Mr. Copp had done. Referring to the First International Gas Conference, Mr. Canning said the Dominion of Canada had shown very good judgment in securing the services of such an excellent representative as Alderman Fred West. "This International Union," went on Mr. Canning, "will add to the work of the President and Council, but I am sure that it will have the best possible effect upon the prosperity of the Gas Industry all over the world. We are all grateful for the very happy friendships we have made during the week with our visitors from Overseas. [Applause.] We owe thanks to-day to many people, and one of them is Mr. Rutter, for his part in the arrangements for this enjoyable trip. We are also grateful to his Grace the Duke of Norfolk and his Agent, for making possible our visit to Arundel Castle. I should also like to express our thanks to Mr. Alexander for the splendid organization of the whole trip. We have already officially thanked our President, but I should like to do so again, and to couple with my proposal the name of Mrs. Copp. [Applause.] She has

done much to make the meeting the great success it has been. We appreciate all that she has done to make us happy. It has been said that the greatest happiness of all is to make others happy; and if that is true, as I believe it is, they must be the happiest of people. I sincerely trust that health, happiness, and prosperity will continue to attend them."

Speaking on behalf of Mrs. Copp and himself, the President said he was delighted to think their modest efforts had met with such high appreciation on all hands. He regarded the Presidency as an opportunity to serve his many friends in the Gas Industry, and appreciation of his efforts was more than sufficient reward. He was pleased to think that Mr. Canning would now undertake the duties of President, because he felt that no one was better fitted to do so.

To See Her is to Love Her.

There had, of course, been insufficient time to seek out all the many attractions of Brighton, but opportunity to do this at their leisure was offered to all the visitors, by means of copies which were distributed of the fully illustrated Official Handbook of the Borough, including facts



and figures, compiled by Mr. C. G. Browne, Publicity Manager for the Corporation. Many who know Brighton best will be inclined to agree with the author that: "You have but to see her to love her, and to love but her for ever."

Luncheon over, motor coaches which were in waiting were boarded, and the journey was resumed, by way of Worthing, to Arundel, where tea was taken at the Norfolk Hotel, and some time was spent amidst the treasures of the Castle and in the stately grounds.

During this part of the day the weather was less kind than it had been in the morning; but the claims of Sussex to admiration were not to be denied, and the drive was thoroughly enjoyed, as was also the return journey round Arundel Park, and through Cuckfield, to Haywards Heath Station, from which point the special train brought us back to London, reaching Victoria promptly on time. There we parted, having already made promises "to see each other again next year."

Evening Star Lodge, No. 1719.

Institution Week Meeting.

We are indebted to the Secretary of the Evening Star Lodge for this notice of the Regular Meeting held on Monday, June 1, in the Grand Temple, Freemasons' Hall, Great Queen Street, at which the Lodge entertained Masonic Members of the Institution of Gas Engineers who were in London for the Annual Meeting. The Worshipful Master (W.Bro. Albert B. Potterton) was in the chair. The ceremony of the evening was the initiation of Mr. Reginald H. Warren (late of the Danish Gas Company). It was performed by the Worshipful Master, ably assisted by W.Bro. J. A. Brentnall, I.P.M., W.Bro. T. F. C. Potterton, S.W., Bro. W. H. Warren, J.W. (brother of the initiate), W.Bro. J. W. Foreman, P.M., L.R., D.C., W.Bro. A. L. Croager, P.M., Acting Assistant D.C., Bro. W. F. Broadberry, S.D., Bro. G. D. Bidwell, J.D., and W.Bro. W. A. Scott, L.R., I.G. The proceedings were prefaced by an organ recital by Bro. J. Waldron Swan, Organist.

Among the many guests who honoured the Lodge by their presence were W.Bro. H. E. de Rougemont, P.A.G.D.C., W.Bro. E. Stamp, P.A.G.D.C., Prov. G.D.C. Warwickshire, W.Bro. S. G. Moss, Prov. S.G.W. Bucks., the President of the Institution, W.Bro. H. E. Copp, W.Bro. W. J. Smith, Worshipful Master of the Northern Star Lodge, No. 3326, and W.Bro. T. H. Poulson, P.P.G.St. Shrops., Worshipful Master of the Murdoch Lodge, No. 3480. Nearly 180 brethren subsequently attended the dinner in the adjoining Connaught Rooms, and the speeches were interspersed with excellent musical items under the supervision of W.Bro. Herbert Townsend, who acted as accompanist.

THE OFFICIAL VISITS

Southall Gas-Works

A large number of members visited the Southall Works of the Gas Light and Coke Company, by kind invitation of the Governor and Directors, on Wednesday afternoon, being accompanied by the President.

The gas-works adjoin the G.W.R. main line not far from Southall Station, and are bordered on another side by the Grand Union Canal. The carbonizing plant is as follows:

(*a*) Woodall-Duckham intermittent vertical chambers consisting of two parallel benches, each containing eight settings of six chambers, 96 chambers in all. The chambers are constructed of Oughtibridge silica, and have a carbonizing capacity of 640 tons per day.

(*b*) Horizontals, consisting of 12 beds of ten retorts, each 22 in. by 16 in. by 22 ft. The retorts are segmental of 95 p.ct. silica, and are operated by Drakes' charging and discharging machine, having a carbonizing capacity of 185 tons.

(*c*) Inclines, consisting of 25 settings of eight retorts, 24½ in. by 14 in. by 20 ft. The retorts are segmental built of 95 p.ct. silica, having a carbonizing capacity of 205 tons per day.

(*d*) Woodall-Duckham continuous verticals, consisting of four settings of four vertical retorts of 95 p.ct. silica, with section 4 ft. 9⅜ in. by 10 in., tapering to 18 in. and 25 ft. long, and a carbonizing capacity of 85 tons per day. All the retort houses are equipped with waste-heat recovery boilers.

Coal-Handling Plant.

The coal-handling plant, supplied by Messrs. Fraser & Chalmers, of Erith, includes Marshall wagon tippler, skip hoist, coal breakers and screens, band elevator and shuttle band conveyor, and saverman drag line scraper. The wagon tippler is of the side tipping type, with a capacity of about 200 tons per hour, and being capable of tipping 8, 10, 12, or 20 ton wagons. Two balanced skips each of 2½ tons capacity hoist 212 tons per hour into the overhead delivery hopper. Robins' grizzly screens of 200 tons per hour capacity are installed, from which the oversize passes to Pennsylvania single roll breakers, 24 in. and 30 in. of 100 tons per hour capacity. The screens and breakers are in duplicate. Coal is stored or reclaimed by a drag line scraper plant. The scraper bucket is of 2 tons capacity, and the storage heap 29,000 tons at 15 ft. deep. The scraper bucket is hauled by winches winding a 2⅜ in. steel rope, and unwinding a 2 in. rope, the latter being used to pull back the empty bucket. A tail car, running on rails laid round the storage heap, supplies the anchorage for the pulleys.

Coke handling and grading plant and hoppers are in course of construction, adjacent to No. 1 retort house. The bunker capacity is 2000 tons. The hoppers are of reinforced concrete with machinery above, including 17 belt conveyors, cutters, screens, dry cleaning plant, dust collectors, and water tank of 100,000 gallons capacity. The installation will be 215 ft. long by 50 ft. wide, and 118 ft. high. Provision is made for loading graded coke into rail trucks, lorries, and barges, and automatic sacking and weighing apparatus for lorry loading will be included. A complete interlocking, starting, and stopping system, bell signalling, and telephones will be provided.

The coke-handling plant attached to the intermittent vertical chamber house attracted the interest of members. The bogey, after receiving the charge from the retort, passes into a quenching chamber at the extreme end of the retort house, and after quenching it is moved outside the house where it is elevated to the top of the house, carried along horizontally until it is above the receiving hopper of the screening plant, and then automatically emptied. The electrical control of these operations is carried out entirely from a control room on ground level, the positions and movements of the coke bogey being continuously indicated by a series of coloured lamps.

The transformer house contains the equipment for stepping-up the voltage to 48,000, and is placed at the rear of the oil gas plant. Two treater chambers are installed, one near the transformer house for oil gas, of 7 million c.ft. per day capacity, and one between sections one and two of No. 1 retort house, of 5 million c.ft. capacity. Provision is made for a second treater at No. 1 house, and additional electrical gear in the transformer house. Two Whessoe washers, each of 7 million c.ft. per day capacity, are installed for extraction of benzole and naphthalene.

There is a Dri-Gas plant, supplied by W. C. Holmes, which has a capacity of 25 million c.ft. per day, and includes two rotary brush scrubbers, with liquor coolers and evaporators. The agent used is calcium chloride, and the liquor is reconcentrated by passing over steam-heated evaporators, then cooled in rack coolers. The evaporators are heated by exhaust steam from the pumps or engines.

The booster and valve house contains three Reavell high-pressure turbo-boosters with condensers, each of 1 million c.ft. per hour capacity, at 80 in. pressure, with steam consumption 4470 lbs. per hour on full load; one Donkin (low-pressure) booster of a capacity of 1 million c.ft. per hour at 30 in. pressure.

Waterless Holder.

The Southall Works includes a waterless gasholder, constructed by Messrs. R. & J. Dempster, of Manchester, of a capacity of 8 million c.ft.; the height overall is 304 ft. and the diameter 203 ft. The holder has 22 tar tanks overhead, and 16 tar tanks at ground level, with 16 electrically driven tar pumps automatically controlled. The piston steelwork weighs 375 tons, and is loaded with 600 tons of concrete blocks to give the working pressure of 12 in. W.G. Outer and inner passenger lifts are provided. There are four other holders of varying capacities from 424,000 c.ft. to 3½ millions.

The oil gas plant building houses five gas-making sets, four being of 1 million c.ft. per day capacity, and one of 2 million c.ft. per day capacity; the large set is fitted with a waste-heat boiler evaporating 3700 lbs. of water per hour. All the sets are hand-operated.

There is various further plant, including station meters, purifiers of total capacity of 11·3 millions of coal gas and 6 millions of oil gas per day, electric generator house, tar and products works, and extensive railway sidings.

After inspection of the works tea was provided by the Gas Light and Coke Company, and the President took the opportunity of thanking the Company for allowing them to see over these works, and congratulated Mr. Thorman upon having such up-to-date plant.

Mr. Thomas Hardie briefly acknowledged the vote of thanks on behalf of the Company, and remarked that when they took over these works they were rather out of date, but in a few years they had made them one of the most up-to-date works in the Company.

Mr. Thorman supported Mr. Hardie's remarks, and said how proud he and his staff were that their works should have been singled out for a visit by the premier Institution in the Industry.

Watson House

At 2.30 on Wednesday a party of nearly one hundred assembled at Grosvenor Gardens to be taken to Watson House in motor coaches, where the Research, Training, and Testing Sections of the Gas Sales Department of the Gas Light and Coke Company were inspected. The visitors were welcomed by the Distribution Engineer, Mr. Stephen Lacey, under whose direction admirable arrangements were carried out with the assistance of Mr. J. G. Clark, Manager of the Research and Training Section, Gas Sales Department, Mr. C. A. Masterman, Senior Chemist, Watson House, and Mr. R. N. Le Fevre.

After a group by the Staff Photographer, which we reproduce on the next page, Mr. Lacey briefly explained to the visitors, assembled in the lecture room, the origin and the many purposes of Watson House; how, by its means, technical co-operation is effected between the far-flung districts of the huge undertaking; how research, aimed principally at solving everyday problems of gas supply, is carried out; how every consignment of material and stoves is tested for soundness before issue; and how staff training is reduced to a fine art. In the last connection, the presence of the party in the lecture room gave the opportunity for a "sample" demonstration of appliances such as is part of the training scheme. So interesting was the sample, that questions were soon being asked by the visitors. After Messrs. Clark and Masterman had been introduced and briefly addressed the party, an admirably clear plan of the department was issued, and the members were invited to inspect exactly that which interested them most. Everywhere members of the Staff were on duty guiding, explaining, and demonstrating, and a most enjoyable and instructive time was spent in an attempt to see all and miss

THE VISITORS TO WATSON HOUSE.

nothing—a welcome respite which many took being a visit to the roof to see the lighting arrangements of the illuminated fascia sign, and, incidentally, a wonderful view of London and its river.

Tea was included in the Company's invitation, and the opportunity was taken by Mr. J. H. Canning, of Newport, Mon., to voice the hearty thanks of those present to the Governor and the Directors for their open-handed policy at all times and particularly for the admirable arrangements on the present occasion, and to Mr. Lacey and the members of the Staff who had made the visit such an outstanding success.

The National Physical Laboratory

AERIAL VIEW OF THE NATIONAL PHYSICAL LABORATORY, TEDDINGTON.

Probably it was owing more to the fact that many of the members of the Institution had visited the National Physical Laboratory on previous occasions than to lack of interest that a smaller number than might have been anticipated travelled to Teddington on June 3. But those who went on this visit were fully repaid by the extremely interesting afternoon spent.

The Purposes of the Laboratory.

The Laboratory was founded in 1900 at Bushey House, an old residence granted by the Crown for the purpose, with grounds covering about 23 acres. Until 1918 the Laboratory was controlled by the Royal Society, when it became a part of the newly constituted Department of Scientific and Industrial Research.

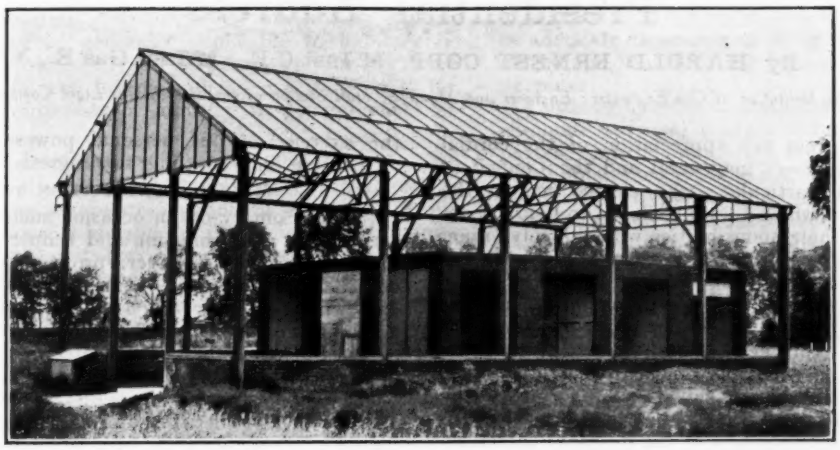
The purposes for which the Laboratory was founded, and which it continues to fulfil, were to carry out research, including especially research required for the accurate determination of physical constants, to establish and maintain precise standards of measurement, and to make tests of instruments and materials. It also undertakes investigations of special problems on behalf of Government Departments, the Research Associations representative of various industries, technical institutions and other bodies, and for private firms. Payment is received for the work done for outside bodies.

The research work of the Laboratory covers a wide field, including all branches of physics, electricity and magnetism, wireless work, engineering metallurgy, aeronautics, and ship design in relation to form and propulsion. With a very few exceptions, tests of all classes of measuring instruments are undertaken, so far as the equipment available will permit. The special investigations made for firms and other bodies are of a very varied character, and the Laboratory is always ready to give careful consideration to any problems or difficulties which may be submitted to it, and to undertake experiments when it is thought that with the facilities at its disposal a solution may be found.

Of interest to members of the Institution was some of the work carried out in the Heat Division, comprising the determination of the thermal conductivity, the thermal expansion, and the specific and latent heats of samples submitted for examination. In this connection reference may be made to the large number of samples of insulating material used in cold storage work which are tested for thermal conductivity, and the heat transmission tests made on building materials.

High Temperature Work.

Much attention is also being given to a careful study of the behaviour of materials at high temperatures.



EXPERIMENTAL ILLUMINATION BUILDING AT THE NATIONAL PHYSICAL LABORATORY.

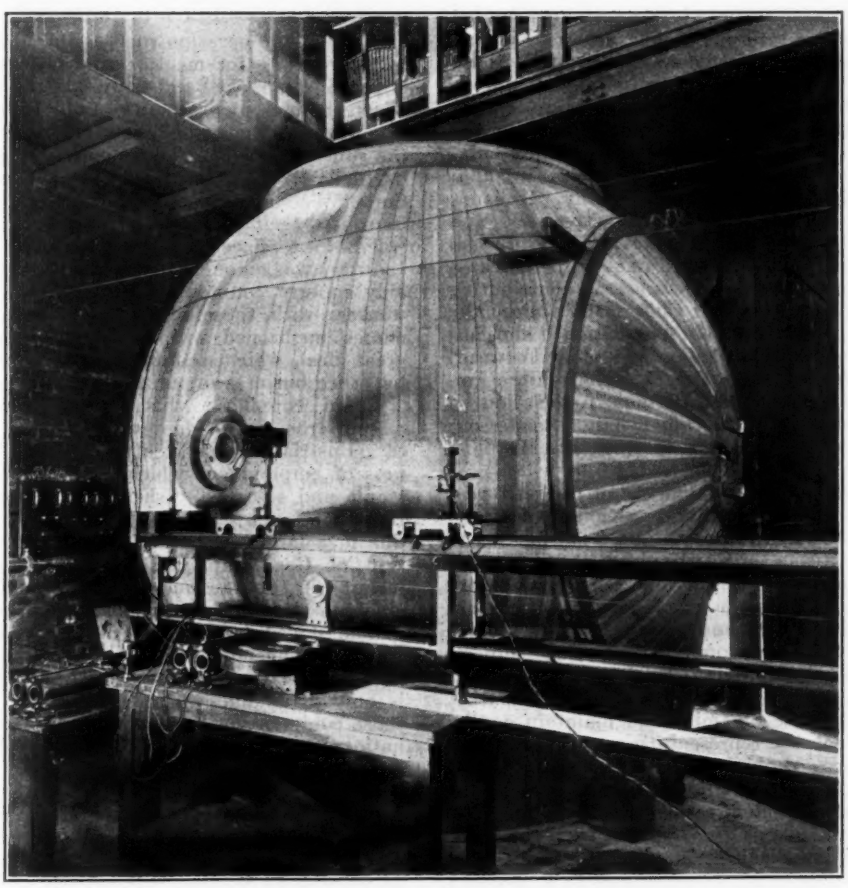
Modern engineering practice calls for materials capable of withstanding increasingly higher temperatures and stresses, and investigations are in progress, again in co-operation with the Metallurgy Department, with the object of improving not only existing materials, but of developing new alloys which will meet the new demands. The "creep" or flow of metals which occurs at high temperatures is being studied under closely controlled conditions.

Much interest was taken by the visitors in the experiments relating to the pressure of the wind on structures, which researches have been continuously in progress since the formation of the Department. They were directed to determining the data needed by engineers for the design of structures likely to be exposed to high winds. The experiments were at first carried out on small models in a wind tunnel, but later tests were made on larger structures in the open. Also of interest were the investigation of methods of testing gears for efficiency; the study of lubrication; investigation into the strength of cylinders used for the storage and transport of compressed gases; the investigation of the vibration of buildings due to traffic and other conditions, and many other problems. The tests made in the Engineering Department included those of all kinds relating to the strength of materials, especially fatigue, impact, wear, and hardness tests.

Tests and investigations relating to road materials are also carried out at the Laboratory, and for some years an extensive series of researches has been in progress on the endurance and wear of roads and the skidding of vehicles on roads.

A chemical laboratory is attached to the Department, which is occupied largely with the analyses required in connection with the metallurgical work, and the work of other Departments of the Laboratory.

The accompanying air view was taken over the National Physical Laboratory in 1929.



THE TEN-FOOT INTEGRATING SPHERE AT THE NATIONAL PHYSICAL LABORATORY.

Presidential Address

By HAROLD ERNEST COPP, M.Inst.C.E., M.Inst.Gas E.,

President, The Institution of Gas Engineers; Engineer and Manager, Hull Station of the British Gas Light Company, Limited.

I must first express my appreciation of the cordial goodwill of the members in general and the Council of the Institution in particular, who elected me to the honourable position which I am privileged to hold. I am fully conscious of the responsibilities which devolve upon me as your President. The duties appertaining to the office call for unremitting diligence and devotion to the service of the Institution. Undertaken with sincerity of purpose, the opportunity of furthering its aims and objects is indeed a privilege. It is a tradition of the Institution that the occupant of the presidential chair can rely upon the help and loyal co-operation of the members and, indeed, of everyone engaged in the Gas Industry. The responsibilities of the position, therefore, may be approached with equanimity.

My immediate predecessor was able to visit every District Association at least once during his year of office. Owing to circumstances beyond my control, I cannot lay claim to such a praiseworthy achievement, although I have, during my year of office, represented the Institution on a great many occasions, at home and abroad.

International Developments.

This, the 68th Annual General Meeting of the Institution of Gas Engineers, is an event of unusual and historical importance, by reason of its being, at the invitation of the Institution, the First International Gas Conference convened as such, with the assent and co-operation of the National Gas Associations throughout the world. Moreover, the Conference is the first to be held under the Statutes of the International Gas Union (Union Internationale de l'Industrie du Gaz), the inauguration of which I hope it will be my privilege to announce at the Session which is set aside to-morrow for International business.

I will not, therefore, anticipate further my forthcoming observations as to the International Gas Union, and it would be appropriate if I deferred until then making any detailed reference to the First International Gas Conference or the individual Overseas Delegates thereto, except to express our salutations and extend the most cordial welcome to our Meeting to the distinguished representatives from the Gas Associations of America, Australia, Belgium, Czechoslovakia, France, Germany, Holland, Hungary, Japan, Norway, Sweden, Switzerland, and Yugoslavia, and to our members present from Brazil, British West Indies, Ceylon, Malta, and South Africa.

Two of our colleagues from overseas are contributing papers to our proceedings; Mr. Clifford E. Paige, the President of the American Gas Association (who has journeyed from America with Major Alexander Forward, the Managing Director), and Dr. H. Schütte, the Immediate Past-President of the German Association of Gas and Water Engineers. On your behalf, I tender our sincere thanks to these gentlemen for their courtesy and their valued contributions.

This gathering and the developments of the past year transcend in importance anything previously achieved internationally in the Gas Industry, and I am pleased to think that the Institution of Gas Engineers has been able to play a by no means inconsiderable part in the work which has been done and to which our Secretary has applied himself with ability and assiduity.

Despite the diversity of opinion on many subjects which exists in the world to-day, Engineers may always meet on common ground and, with mutual sympathy, promote the great cause of amity and maintain cordial relationships between the representatives of the different Nations. Differences of opinion are not wholly evils. It is by variations of thought and character, due to the development of the individual rather than collective consciousness, that humanity is distinguished from the lower creation. To avoid syndicalization of mentality we must guard against the danger of being reduced to a common level, or of being herded into groups, for it is only by the exercise of our personal powers of thought that civilization may continue to progress.

Municipal Opposition to Gas.

It is customary on an occasion such as this to present a review of the Profession and Industry to which we belong. I do not, however, propose to be either retrospective or prophetic. The year 1930 opened with a cloud hanging over the coal industry, and at the end a calamity even more threatening was only dissipated by a series of somewhat complicated expedients, which we hope may possess some stability.

Mr. Thomas Goulden in his Presidential Address in 1921 (which was written during a great Coal Strike) predicted a severe struggle over an indefinite and lengthy period. We all realize how accurate his forecast was. Each succeeding President has indicated difficulties ahead which would have to be overcome, and in reading their Addresses I have been impressed not only with their applicability to the present situation, but also with the success which has been achieved in surmounting most of the obstacles that have hindered progress. Few of my predecessors, however, would have imagined that—in our day and generation—municipalities which are owners of electrical undertakings could have taken up such an unfair attitude as, for example, to prohibit the use of gas for lighting in houses erected at the expense of the ratepayers. This intolerable position is one which would seem incredible. It is certainly quite out of harmony with what we fondly imagine to be the spirit of a democratic age. Every business should be free to develop on its own merits; nothing can be eventually gained by artificial boosting, however much it may appeal to the national or local custodians of the public purse, who have still to learn the lesson of economy in public expenditure.

Peace in Industry.

On a unique occasion such as this, I feel that it would be appropriate for me to pay a tribute to the memory of those who so well and truly laid the foundations upon which the present prosperity of our Industry and Institution rest, and upon which we are to-day engaged in adding the superstructure. Their names are many, but I would particularly refer to those of Sir George Livesey, Sir Corbet Woodall, and Charles Hunt, all of whom indelibly imprinted their names on our history and whose influence will not be effaced by the passing of time. The Gas Industry was amongst the first in this country, and probably in any country, to correlate the interests of the workers with those of the employers. The first two names mentioned will always be associated with that great ideal, which we hope may be emulated in due time by other business organizations both great and small.

I am convinced that, apart from unemployment arising from trade depression, one of the chief causes of industrial unrest is attributable to the precariousness of employment which exists even in many of our staple and so-called "sheltered" industries. Happily, there is no such feeling of insecurity in the Gas Industry, due in a large measure to the activities of the Federation of Gas Employers, by whose efforts a general feeling of mutual understanding and trust has been created. Matters affecting relations between employers and employed are discussed in an atmosphere of candour, which has engendered that all too rare spirit of reciprocity and ability to understand each other's point of view, and is only attainable when both parties are imbued with those common ideals which are associated with our best national traditions. We may justly claim that the absence of serious disputes in the Gas Industry during a period of many years, has proved that our workers realize their point of view has been sympathetically considered, and to this may be attributed their undoubted loyalty and their recognition of the fact that they serve its interests in common with ourselves.

In February, 1931, the National Confederation of

Employers' Organizations issued a notable Report on the Industrial Situation. Although the statements therein contained may be generally applicable to industry in this country, fortunately they do not apply in any large measure to our own internal affairs, excepting in so far as the larger interests of industry in general affect us indirectly.

Inequitable Wage Levels.

The great disparities which exist between ourselves and our foreign competitors permeate the whole of our industrial and social life and are illustrated by the following tables in the Report:

A. *National Taxation.*
Disparity in National Taxation per head of population (Hansard, Nov. 4, 1930).

B. *Wage Levels.*
Disparity in level of real wages expressed in purchasing power (Ministry of Labour Gazette, 1929-30).

C. *Social Services.*
Disparity in cost per head of population for the five Social Services, namely, Unemployment, Health, Workmen's Compensation, Old Age Pensions, and Poor Law Relief.

Thus the position is:—

	A.	B.	C.
Great Britain	100	100	100
France	64	59	17
Germany ...	50	74	48
Belgium	38	50	7
Italy	30	45	4

These figures reveal a state of affairs which demands our very serious attention. In principle, I am definitely opposed to any lowering of the standard of living, for I believe that in its maintenance lies the highway to national prosperity and contentment. The standard, however, can only be upheld so long as industry is capable of paying for it, and that, in turn, is dependent upon our ability to pay reasonable dividends, so that the necessary capital may be attracted, business and enterprise encouraged, and command of the markets of the world retained.

The Report recommends that the Government should revise wage levels in relation to those of exporting industries, and appeals to all local authorities to adopt the same policy and to see that grants made to them are not used in paying higher rates to their employees than to men of corresponding skill engaged in the exporting trades of the same locality. This is one of the great causes of industrial unrest since the value of work must be the ruling factor in determining wages in industry. Municipal workers are often overpaid in the light of the foregoing postulates, and this frequently gives rise to discontent amongst other bodies of workers. There is no doubt that relatively too much is paid for some classes of work and too little for others.

Evils of Rationalization.

Democratic Government is, to a great extent, a fetish, and may well mean a loss of liberty of the subject and a suppression of minority interests. From the distinct tendency to-day to admire the art and civilization of past days, one may infer that some discontent exists with modern conditions. It is, indeed, questionable whether people are happier to-day than in former generations.

It is a common practice nowadays to speak of Rationalization as a way out of all our national difficulties, and well it may be, if it is in fact rational in its application to the industry concerned. The Gas Industry has followed the practice to a logical extent, for, as we know, during the past few years there have been many instances of small gas undertakigs amalgamating with larger ones, and so enabling the community concerned to be supplied with gas on more favourable terms. There are, however, limitations to such amalgamations, since the economies in manufacture must not be exceeded by the added costs of distribution. This is the great problem with which the Electrical Industry is faced, and is one which can only be solved in the process of time. It would be a negation of the idea of Rationalization if the coke oven owners were to be given the power to distribute their surplus gas to the consumers of statutory gas undertakings, if for no other reason than that they have no adequate experience of the problems of the distribution of gas and its utilization for manufacturing and general purposes.

Another objection to Rationalization is that it tends to eliminate personal contact between employers and employed, thus counteracting the influence of a very valuable human factor. The satisfaction of serving one's employers directly, and thus one's day and generation indirectly, is surely an incentive to the achievement of a worthy ideal. In many works where no profit sharing or co-partnership system exists, an attempt to secure this desirable object has been made by establishing Works' Committees. My experience has been that such Committees often fail in their purpose, because the matters brought forward for discussion are usually those of detail rather than principle. It is preferable that the person responsible for the management should be freely accessible to every employee. It will be found that this is a privilege which is seldom or ever abused. I would plead for a high standard of maintenance not only on the works, but in every department. Neglect of this is not only false economy but is inimical to the principles I have enunciated, and thus to the continued prosperity of the undertakings concerned. Ideas for improvements which emanate from employees should be suitably rewarded, my personal experience being that the recognition of such ideas, when successfully applied, has been amply justified and duly appreciated.

Amenities for Workers.

Standardization in materials and methods of production certainly have their advantages, but we must guard against any attempt to standardize our fellow men; they are all separate entities and must always be regarded as such. The danger of over-standardizing our appliances should be avoided, since Emulation results in Evolution.

The provision of facilities for the recreation of employees is of far-reaching importance. At the Hull Station of the British Gas Light Company we are singularly fortunate in that we have a considerable area of land which is used by the various recreation clubs. The existence of these clubs exercises a marked and beneficial effect on both officials and employees, and encourages the team spirit.

As long ago as 1908, my esteemed predecessor at Hull, Mr. John Young, who was President of the Institution in 1916, established one of the first works' surgeries in connection with any industrial undertaking in the country. The benefits of this soon became apparent, and proved of such service not only to the men, but also indirectly to the Company, that in 1923 it became necessary to provide additional accommodation. The Court of Directors, therefore, decided to erect a new building to take the form of a memorial to those of their officials and employees who made the supreme sacrifice during the Great War. We now have a well equipped surgery which is doing magnificent work for the welfare of our men. It is in charge of a qualified surgical dresser and under the direction of a part time medical officer. We find that the men eagerly avail themselves of the services provided, and benefit by the instruction which is given in the general principles of hygiene and the prevention of accidents.

Work of the Institution.

The record of the work of the Institution during the year 1930-31 is contained in the Annual Report, and you will not, therefore, require me to do more than make one or two comments on the progress which has been made. The accounts show a very satisfactory position, having in mind our extended activities and the increased expenditure involved by the long deferred re-housing, re-equipment, and refurnishing of the Council Chamber, Library, and Offices of the Institution, and the entire reorganization of the administration.

As you are aware, the granting of the Royal Charter necessitated the winding up of the affairs of the Old Institution. This was effected at the last Autumn General Meeting, and our thanks are due to the Secretary, Mr. J. R. Willis Alexander, for his valuable services as liquidator. I should also like to pay a very high tribute to

Mr. Alexander and to each member of his staff for their very efficient and assiduous services to the Institution during the past year.

Membership and Education.

The membership on December 31, 1931, was 1444, showing an increase of 39 as compared with an increase of 5 in the previous year. The qualifications for membership set by the Royal Charter, the stringency of the requirements as to education and training and the nature and limited extent of our profession, necessarily restrict our numbers, but the position cannot be regarded as anything other than highly satisfactory. There is increasing enthusiasm on the part of the younger gas employees to train, educate and equip themselves for admittance to the Institution, and I urge the responsible officials of gas undertakings to give such candidates every encouragement and assistance. Education in itself, however, is not sufficient; we must not lose sight of the importance of the cultivation of character and personality, both of which are necessary to those who are destined to play a large part in the future administration of the Industry, involving as it must, the control of numbers of men. The increase in the number of gas undertakings taking indentured apprentices is a step in the right direction, our national reputation as craftsmen having been built up under the system of apprenticeship. The gas engineer must be a person specially qualified to exercise the practice of forethought and enterprise. In many instances, he is, alas, inadequately remunerated for the great responsibilities he bears. Gas is taken for granted. Almost unfailing, it is the most reliable commodity supplied to the public. It will be generally agreed, therefore, that the skill and devotion of those responsible for its manufacture and supply are worthy of honourable recognition.

Research.

Our gratitude is due to those who devote so much of their time and energy to the immense amount of work involved in the educational and research work of the Institution. The Chairman and Members of the Committees entrusted with this work are most enthusiastic and assiduous in the task they have undertaken and merit the gratitude of every member. Their labours continue to produce results which are of value to the Gas Industry at home and overseas, although, unfortunately, the duties rest upon relatively too few shoulders.

During the past year two permanent Committees have been set up by the Institution—a Street Lighting Committee and a Tar Sub-Committee—whilst several Joint Committees dealing with various matters affecting the prosperity of the Industry as a whole have been formed in association with the National Gas Council, the British Commercial Gas Association, and the Society of British Gas Industries. The aims and objects of the Institution and the other gas organizations being so closely allied, we have pursued with increasing vigour our policy of co-operation between the representative bodies of the Industry. Each should candidly recognize the peculiar functions of the others, and there should be that unity of purpose which means strength. In pursuance of this principle the Institution has sought in greater measure the co-operation of chemists and of manufacturers of gas apparatus and appliances, and their work is reflected in the activities of the General Research Committee and the Sub-Committees dealing with Calorimeters, Corrosion of Pipes, Gasholders, Liquor Effluents and Ammonia, Meters, Purifiers, Refractory Materials, Street Lighting, and Tar.

Most of us will watch with interest the deliberations which have been initiated by the Institution in connection with a possibility of inaugurating a Scheme for the Certification of Gas Appliances, so that inferior types of apparatus may not be offered for sale. This is no new idea; I advocated it myself in a short paper read before the Midland Association of Gas Engineers in 1908, and it has already been carried into effect in America, Canada, and France. Such a proposal deserves every consideration. It would involve increased co-operation between the Institution and private research laboratories, the collation of existing information and, ultimately, the provision of additional research staff, including a distinguished chemist and physicist, and a laboratory equipped with adequate apparatus. The Council, on behalf of those interested in the project, would welcome constructive proposals dealing not only with the scope and limitations of such an extension of the research work of the Institution, but also with the possibilities of financing it.

Gas Appliances.

I agree with those who hold that there is great need for the further improvement of gas lighting appliances. Although much has been done to increase efficiencies by pre-heating, still better results would be obtained if more of the waste heat could be imparted to the secondary air necessary for complete combustion. An addition of only 100° C. to the flame temperature would result in a much enhanced brilliancy.

With regard to heating, while it may be said that the gas fire radiates from 50 per cent. to 60 per cent. of the heat of the gas consumed, our electrical competitors claim a radiation of 100 per cent. for their appliances. They conveniently ignore ventilation, which is quite as important as warmth. The erection of houses without flues, irrespective of any method of heating which may, or may not, be employed is—on elementary hygienic grounds—little short of a scandal.

In connection with industry, the word "Rationalization" might well give place to "Research." It can be justly claimed that very few industries have devoted more attention to research than the Gas Industry, though whether we have taken the fullest advantage of the vast amount of work which has been done is open to some question. At Leeds University much research has been carried out under the auspices of the Institution. The Fuel Research Board has successfully investigated many problems of great importance affecting the affairs of the nation, as well as those of fuel technologists in general. Notwithstanding the fact that several of the larger gas undertakings have also pursued various lines of research in connection with the problems of fuel utilization, I cannot help feeling that some means should be devised whereby overlapping and the duplication of effort might be avoided. Our thanks are due to the Gas Light and Coke Company, the South Metropolitan Gas Company, and the Birmingham Gas Department for the generous manner in which they permit the results of their very thorough investigations to be made available to the Research Committees of the Institution and so freely utilized for the benefit of gas undertakings throughout the country.

Problems of Manufacture.

I will now pass on to deal very briefly with certain matters relating to the manufacture of gas. There are some who think that calorific value should be standardized, and we have strong advocates of both high and low standards. In my opinion, the fact that the Gas Regulation Act left the choice of calorific value open to each undertaking operates to the great benefit of the Industry. A simple calculation will determine the value which shows the greatest pecuniary advantage, due regard being paid to the needs of every particular locality. Very high thermal yields are not necessarily the most economical or satisfactory, the price and quality of coke and the percentage decomposition of steam to obtain such results being often the dominating factors.

It is not necessary for me to emphasize the desirability of adhering strictly to the declared calorific value. At Hull we formerly worked to approximately 85 therms, but now find that with a town gas of 460 B.Th.U., about 78 therms is a more economical figure. A "Thomas" calorimeter has been in use for the past seven months, and against the record of this instrument no less than 450 check tests have been made with an ordinary "Boys" calorimeter. It is interesting to note that the variation has never exceeded $\pm \frac{1}{2}$ per cent. Coloured electric signal lamps are fitted in various parts of the works which indicate the reading of the instrument, a device which facilitates the control of the calorific value within very narrow limits.

Although, during the past year no striking new methods of carbonization have been introduced, steady progress is being made. The study of the manufacture and the

selection and uses of refractory materials is certainly conducive to better and more efficient carbonizing practice, to which end much assistance has been rendered by our Refractory Materials Joint Sub-Committee.

Prevention of Spalling.

Carbonizing at Hull is carried out exclusively in vertical retorts of the Woodall-Duckham type with silica retorts. The silica band in the retorts of the oldest bench is 17 ft. 6 in. deep, and in the case of the other three benches 19 ft. The more general use of silica material in later years has no doubt lengthened the life of retorts, but it has been found that with the type of retort in use at Hull severe erosion takes place at points approximately 8 ft. and 4 ft. from the top of the retort. This action, which is attributed solely to spalling, is most rapid when the retorts are new and slows down as the thickness of walls is decreased, when the heat transference from the combustion chamber becomes more rapid.

In an attempt to prevent this spalling, experiments are now in progress, using various materials in this zone. The materials under test are:—

Maker A.—Sillimanite.
Maker B.—Ordinary silica.
Maker C.—Double burned silica.
Maker D.—Ordinary silica.
Maker E.—Ordinary silica.

It has not yet been possible to let down the bench for a cold examination, but as far as can be observed at present, after nearly two years at work, the order of merit of the materials as regards freedom from spalling is as follows:—

Maker A.—Sillimanite	First.
Maker B.—Ordinary silica.	Second (almost as free from spalling as sillimanite).
Maker C.—Doubled burned silica.	Third.
Maker D. and E.—Ordinary silica.	Fourth.

Life of Silica Settings.

With regard to the life of silica settings, the following figures may be of interest:—

	No. of days' actual work.
No. 2 retort house.—" A " bench	1816
" B " bench	1282
No. 3 retort house.—" A " bench	1734
" B " bench	1163

It is confidently expected that " A " bench in No. 2 retort house will give at least a further two years' useful work, and that the remaining benches will equal this life before needing resetting.

Taking " A " bench then as an example, the following figures give the actual life and throughput to 31st March, 1931, and in the right-hand column is given the estimated total life and throughput. The yield of gas over the period under revision for the bench has averaged 80 therms with a finished gas of 480 B.Th.U. per cubic foot. The temperatures at which the settings have been worked are 1380° to 1400° C. at the top and 1150° to 1180° C. at the bottom.

Five-Ton Woodall-Duckham Vertical Retorts.

" A " Bench No. 2 Retort House.	To March 31, 1931.	Estimated Total Life.
Days actual work under fire	1816	2500
Scurfing periods of life (per cent.)	8·5*	8·5
Actual carbonizing life, less scurfing periods (days)	1662	2288
Throughput per retort per day (tons)	5·5	5·5
Tonnage per retort	9141	12,584
" " bench	146,256	201,344
Cost of reset of bench per therm gas made	0·147d.	0·107d.
Cost of repairs of bench per therm gas made	0·050d.†	0·044d.‡
	0·197d.	0·151d.

Notes.

* This represents approximately 60 hours from gas making to gas making per retort for each scurfing period, the carbon being burnt away without employing tools for hastening the process.

† Includes cost of removing recuperators and replacing with simple secondary air and waste gas flues.

‡ Estimated. Cost of repairs will not be so heavy in last two years, as no major repairs will be carried out prior to resetting.

Coal Supplies.

A matter of fundamental importance to the Gas Industry is that of our raw material—coal. It is, therefore, very gratifying that such an authority on the subject as Dr. R. Lessing is submitting to this meeting, at my personal request, a paper on " Clean Coal in the Gas Industry." Many fear that Governmental interference with the coal industry or, what would be worse, its nationalization, would be fatal as regards the supply of our constant requirements of reasonably pure coal at economic prices.

It is sometimes contended that the Gas Industry is paying too little for its coal. I suggest, however, that in view of the definite and constant demand and the efficient manner in which its supplies are utilized, the Gas Industry should receive every advantage other than those inherent in the pernicious principle of preferential treatment.

Much may be done in the laboratories of even moderately sized gas-works in the selection and blending of coals, by the judicious use of the Gray-King apparatus. By its means very useful information may be deduced as to the quantity and quality of gas, coke, tar, and liquor, the swelling characteristics of the coal, and the rate of carbonization. The results, although only relative, may be easily correlated with those obtainable in practice. The ignition temperature of coke, its reactivity in the presence of oxygen and carbon dioxide may also be determined for the purpose of evaluating its use for the production of water gas and its suitability for the domestic grate.

Depressed Bye-Product Markets.

The revenue obtained from Coke is a dominating factor in the price of gas. We must, therefore, devote the closest attention to its production. The choice of coals and their blending, ash and sulphur content, should be carefully considered so that a smokeless fuel may be offered to our consumers which will fulfil all their requirements. Having obtained a chemically and physically suitable coke, the provision of screening and grading plant, as well as an efficient selling organization, is to-day an absolute necessity. It must always be remembered that most of the smoke which excludes the sunlight from our industrial centres of population emanates from the domestic chimney, and that the further popularization of the use of coke would do much to mitigate the smoke nuisance.

The Tar market is suffering from a marked depression. The severe competition which exists in most of our industrial areas has resulted in low prices being realized for prepared tar for road purposes. Unfortunately, this coincides with an exceptionally poor demand for other products from distillation owing to world over-production.

Investigations relating to the effect of the cracking of tar vapours may well lead to the production of road tar materials of greater value than those at present in use. Tar produced by some modern and efficient methods of carbonization may not completely comply with existing Specifications, but proof is lacking that they do not fulfil all practical requirements. It has admittedly been found difficult to comply with the usual specifications for tar produced in works where all the carbonization is carried out in steam vertical retorts, and particularly since the superior qualities of coals have been used. As the difference in the manufacture of horizontal and vertical tars is one of cracking, it should be possible to subject the vertical tar at present obtained to successful treatment. A laboratory investigation is in progress at Hull to determine how far this can be done.

The inevitable production of Ammonia in the process of gas manufacture has almost ceased to be a source of profit, and in many instances involves a definite loss to gas undertakings. At the moment the world's production of ammonia is in excess of its requirements, and the development of the synthetic process has become the governing factor affecting the prices obtainable for ammonia.

Low-Temperature Carbonization.

There is a popular belief that the Gas Industry is necessarily opposed to the principle of low-temperature carbonization. There could be nothing further from the

truth. We are always striving to attain the best results, and are certainly well qualified in carbonizing practice to adapt ourselves to any new conditions, and already possess much of the necessary equipment and organization. Many systems of low temperature have been tried on a large scale, but, up to the present, none has achieved commercial success. If better methods for the treatment of coal are evolved, the Gas Industry will have no difficulty in financing such improvements. The confidence of the investing public is a sure indication of the position of the Industry.

Oil from Coal.

Much attention is being directed to the possibilities of converting a larger proportion of coal derivatives into motor spirit and fuel oil, and this must be admitted to be a subject of great national importance in view of our almost complete dependence upon imported oil and spirit for the propulsion of our ships, aeroplanes, and motors. The Fuel Research Board has already succeeded in evolving a commercially successful method for the hydrogenation of coal products, which has resulted in the production of some 14 gallons of motor spirit and 4 gallons of neutral oil per ton of coal treated. This is a line of research which may be profitably pursued by gas undertakings possessing the necessary resources.

Electrical Competition.

In the face of the intensive campaign which has been launched by the electrical industry with the aid of Government finance and newspaper publicity, I would stress to the utmost that those engaged in the Gas Industry are called upon for greater individual and collective effort. We have a good case, based upon scientific and economic grounds, in that we are able to transform some 85 per cent. of the available energy contained in our raw material—coal—into gaseous and solid fuel and products, whereas the electrical industry falls far behind from the points of view of economy and the conservation of our national fuel resources. This fact must not, however, give rise to any false feeling of security on our part. You will probably have noticed that the full cost of a modern up-to-date electrical generating plant is a very small proportion of the total cost of the current.

The adaptability of the Gas Industry to changing circumstances is little short of a romance. We have more than made up our losses on lighting by our increased industrial load. It is obvious, however, that the merits of gas lighting are not receiving the attention they deserve during the present craze for electric lighting. People have not recognized the superior quality of gas lighting and the convenience, or even the existence, of gas switches. The assertion that electricity is the only satisfactory means of modern illumination is based on the fallacious notions of those who are directly interested or who are obsessed by the idea that they are quite up-to-date and fashionable people. The Socialist should logically be a gas enthusiast, not only on account of the larger number of men employed by the Gas Industry *vis-à-vis* the electrical industry, but also because the Gas Industry supplies light and heat to many millions of working-class homes at prices which can be afforded by wage earners.

A certain section of the electrical industry has recently adopted new tactics in its salesmanship. Whereas we have hitherto refrained from publishing any derogatory statements relating to our competitors, I have recently seen pamphlets containing very unfair and often untrue statements concerning the use of gas for cooking and heating. I have no hesitation in recording a strong protest against such unscrupulous methods of propaganda. The electricians appear to be derisive when the subject of gas lighting is mentioned, and try to convey the impression that for this purpose it has had its day. I maintain, however, that gas lighting—properly installed and effectively maintained—will be still appreciated and extensively employed on its merits by those who are buyers of artificial light as a commodity.

The competition of electricity can only be met by a greater expenditure on our distribution services. The gas consumer *must* be satisfied. Consumers are so numerous that they should be mobilized, for they may well exercise a steadying influence on domestic politics. Our responsibility and our opportunity is a great one.

Distribution.

Turning to the important subject of distribution, I am confident that many of our problems may be solved by the extended use of steel mains under high pressure. In Hull we have recently laid a high pressure gas main which is 15 in. diameter and nearly four miles in length. This will not only supply a newly developed area, but will supplement the supply to a remote district and feed into the existing network of mains from the opposite direction and equalize the pressure throughout the distributing system, an advantage to which Dr. Schütte adequately refers in his paper. Still greater attention must be paid to salesmanship and service to the consumer, particularly with regard to the maintenance of gas appliances and the use of gas switches and gas apparatus in industrial processes. The latter presents the most promising field for the expansion of our business, but, up to the present, has only received the attention it deserves in relatively few centres, notably, Birmingham, London, and Sheffield. It is satisfactory to note, however, that the matter is being considered by a Joint Committee which is endeavouring to co-ordinate our efforts in increasing the demand for gas by manufacturers.

Gas Charges.

In order that this desirable object may be attained, it is necessary that the Gas Industry should have greater freedom in its methods of charging for its primary commodity. The introduction of differential charges for gas would have the further advantage of enabling us to meet the competition of cheap imported fuel oil, which is being extensively used for the heating of large furnaces and which also affects the markets of our products from tar. I regard this question of charges as one of our most pressing problems, and am pleased to see the subject so ably dealt with by the President of the American Gas Association in his paper.

The Future.

The Gas Industry is a very reliable barometer of the state of trade in the country, and any influences which affect the free circulation of money and the purchasing power of the community, are instantly reflected in the revenue returns of gas undertakings. Any industry which retains its capital value and can show steady progress in the face of world-wide business depression and a well organized campaign of opposition, need have little fear of the future if those engaged in it remain steadfast and devoted to the best interests of their calling, remembering that this is a time for vigorous action rather than complaisance.

Although the larger undertakings are better able to take care of their own affairs, my sympathies are largely with the smaller works, which do not always possess the necessary resources to meet present day conditions. For the most part they are putting up a brave fight, but it is incumbent upon us—and the Institution is not unmindful of the fact—to render them all the support we can.

I have undiminished confidence in the future prosperity of the Gas Industry. For heating and industrial applications gas has an unlimited field, but much remains to be done to bring home its advantages to the mind of the general public, and to prove that as a nation we cannot afford to purchase the comforts and amenities of life at anything but the most favourable prices.

Conclusion.

It may appear that the subject matter of this Address is somewhat discursive. I have superficially touched on a large number of matters and purposely avoided the consideration of technical details. There are a number of other topics to which I would have referred had time permitted, but I have interpreted my duty on this occasion as that of presenting a general survey of some of the problems with which we are confronted, and of endeavouring to convey some of my thoughts.

In conclusion, I should like to express my thanks to the Chairman and the Court of Directors of the British Gas Light Company, Ltd., for granting me permission to undertake the duties appertaining to the Presidency of the Institution of Gas Engineers.

Intermittent Vertical Chambers and Coal and Coke Handling Plant at Southall

By J. S. THORMAN, M.Inst.Gas E.,

The Gas Light and Coke Company.

INTRODUCTION.

The Directors of the Gas Light and Coke Company, on the advice of the Chief Engineer, decided to install a carbonizing unit of about 10 million c.ft. per day capacity complete with coal and coke handling plant, for the Southall Works, to replace an old inclined plant which had reached the end of its life.

An old inclined house and coal store was demolished, to provide a convenient site with reasonable area for coal and coke handling plant.

It is an interesting fact that the new carbonizing plant (and coke transporter), with a production of 54,000 therms per day, occupies practically the same ground space as the old inclined house, with a maximum production of 13,500 therms, that is four times the yield.

The question of the type of carbonizing plant had to be carefully considered; the determining factor in the decision of the plant was the fact that transport of seaborne coal is considerably cheaper than that of railborne coal. Durham coal is transported to Southall from the North by sea to Beckton, where it is transhipped into 300-ton river barges, thence to Brentford, where it is transferred to 20-ton railway wagons at the G.W.R. Coal Handling Plant, and by loop line to Southall.

In spite of these various transfer and handling charges Durham coal is so considerably cheaper at Southall than railborne coal that it was essential that Durham coals should be efficiently carbonized in the plant selected.

Horizontals were naturally considered owing to the excellent carbonizing results obtained in modern horizontal installations with Durham coals.

The advantage of steaming with verticals and the consequent flexibility in quality of gas produced favoured the adoption of verticals.

The Chief Engineer has installed in recent years continuous verticals at several of the Gas Light and Coke Company's stations, in which Durham coal is efficiently carbonized, and it was considered advisable to obtain experience with Durham coal in intermittent vertical chambers, and for this reason he decided to recommend intermittent vertical chamber ovens for Southall provided that it could be established that they were satisfactory on the following points:—

Capital cost.
Labour cost.
Life.
Maintenance.
Fuel consumption.
Quality of coke.

The author had the opportunity of inspecting in Germany a number of intermittent vertical installations of various design, and the evidence obtained as to their suitability under these headings was very convincing.

Tenders were therefore obtained, and the Woodall-Duckham chamber ovens were accepted. The plant was erected during 1930 and put to work in October of that year.

DESCRIPTION OF PLANT.

Figs. 1 and 2 are diagrams showing in end elevation and plan the general layout.

The first section consists of 48 chambers arranged in two parallel benches of equal size.

A second section of like capacity is now in course of construction.

Each bench comprises four individual settings, each setting consisting of six chambers on the side nearest the middle of the house and a producer between two recuperators on the outside.

The construction is such that any one setting can be heated up or cooled down without interfering with the working of the other settings.

The Chambers.

The chambers, which have a capacity of 3·6 tons of coal each, have an overall height of nearly 22 ft. and are supported on seating-castings resting, 10 ft. 7 in. above the floor level, on deep joists. Attached to the underside of each seating-casting is the bottom door frame. Through ducts in these castings the steam used for water-gas production is admitted when carbonization of the charge is complete.

The chambers are built of first quality silica material throughout their heated height of 19 ft. 6 in., are rectangular in plan, have a major axis length of 10 ft. at the bottom, and have a uniform taper from bottom to

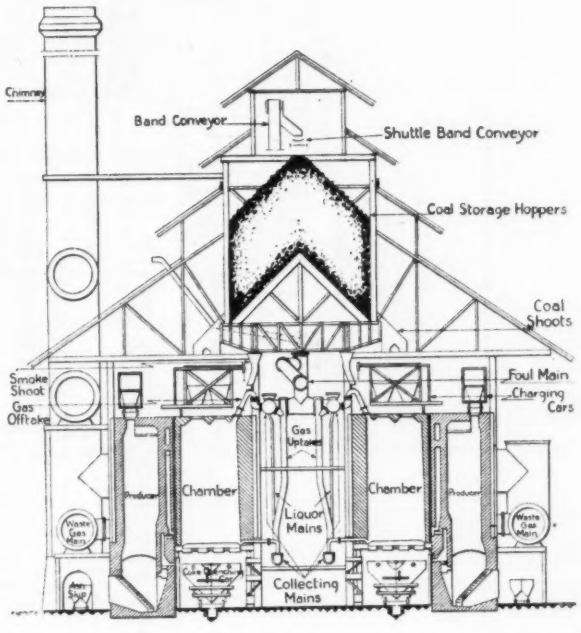


FIG. 1.

top of the minor axis to ensure unaided discharge of the coke when carbonization is complete.

The method of construction adopted ensures maximum strength without the necessity for "arching" or "cambering" the side walls. The absence of "camber" on the side walls ensures uniform carbonization across the whole width of the charge.

The Producers and Recuperators.

The producers and recuperators occupy the full 32 ft. 6 in. height of the settings from floor-level.

The recuperators, which are situated one on each side of each producer, are of the counterflow type.

The producers are of the standard Woodall-Duckham step-grate type, with ample grate area. They are fitted with doors and Venturi injectors so that they may be worked under pressure when using coke of small size or high ash content. Each producer has two charging-

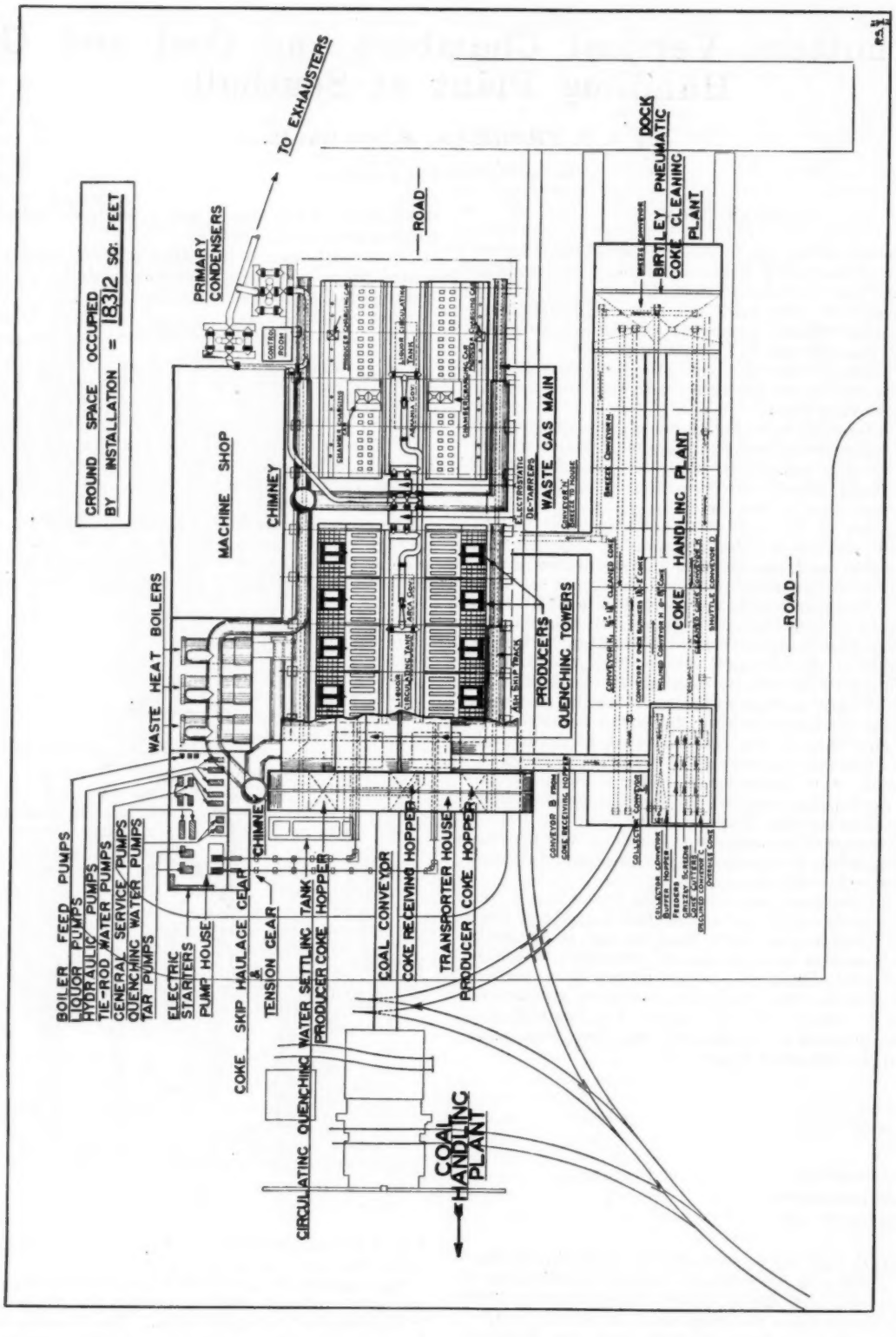


FIG. 2.

holes fitted with cast-iron lids and contains three step-grates, there being one door for each grate.

Chamber Heating System.

The combustion system for heating the chambers is efficient and simple to control.

Hot producer gas and hot secondary air are brought together in a horizontal combustion flue near the bottom of each chamber, there being seven such flues for each setting of six chambers. Some of the hot combustion gases travel horizontally along the full major axis length of the chambers and the rest flow upward through suitable by-pass openings. The combustion gases flow partly horizontally and partly vertically to the tops of the chambers through five more horizontal flues, in each of which the temperature is uniform from end to end.

The flue temperature at the top of the chambers is 350° to 400° C. lower than at the bottom, but the influence of this temperature drop on the process of carbonization is counterbalanced by the decrease in the minor axis width from bottom to top of the chamber. It is found in practice that the charge of coal is carbonized equally from bottom to top.

From the chamber top flues the hot waste gases flow across into and then down through the recuperators; from the bottom of each recuperator they pass up through

the setting main waste-gas damper ports and then out through a neck into an overhead outside waste-gas main consisting of a cylindrical steel casing riveted together in sections and lined throughout its length with firebricks and insulating material.

Setting Bracing.

Each setting is systematically and very strongly braced, a matter of supreme importance with intermittent vertical chambers, especially when these are constructed of silica.

In this connection may be mentioned the use of water-cooled tie-rods, through which softened water flows on its way to the boiler feed tank, a somewhat novel feature which, in conjunction with other special features in the design of the settings, has obviated any appreciable deflection of the buckstays and has entirely prevented any deformation of the chambers. In consequence of this no difficulty is experienced in dropping any coke charges unaided, despite the high swelling properties of the coals used.

Chamber Charging Plant.

Above and between the two benches is situated a steel storage hopper having a " live " capacity for coal of 650 tons, this being about 48 hours' supply.

At one end of this hopper is a separate storage compartment for the small coke used for protecting the chamber bottom doors and for covering the chamber bottom fireclay blocks.

The combined overhead storage hoppers occupy the full length of the benches, and are fed by the band elevator and shuttle band conveyor which is referred to under coal handling plant.

The storage hoppers are fitted with a number of twin shoots for filling the electrically-propelled charging cars, one of which is provided over each line of chambers.

Each of these charging cars has a specially designed slung coal hopper of about $3\frac{3}{4}$ tons capacity, in which each coal charge is weighed, and a separate divided compartment constructed to hold 5 cwt. of small coke for a single chamber pad at the bottom with two more coke-pads above.

The charging hopper shoots and their operating mechanisms are so designed that—

(*a*) No coal can be charged into a chamber until the doors below the single coke-pad compartment have been opened,

(*b*) The coke pad is distributed uniformly over the length of the chamber bottom door, and

(*c*) Coal charging is rapid.

The two charging holes at the top of each chamber are provided with self-sealing doors mounted on frames bedded in the top fireclay blocks, the frames being strongly braced so that the chamber top fireclay blocks of the whole of each setting form one robust raft. Each frame is fitted with a hinge and a latch, and each door is attached to its hinge by means of an eccentric lever whereby the door can quickly be tightened or released.

Gas Offtakes and Collecting Mains.

The correct design of gas offtakes and collecting mains and the adequate employment of liquor sprays are factors of very considerable importance for the successful operation of intermittent vertical chambers.

At one end of the top of each chamber is provided a top gas offtake consisting of an arched cast-iron pipe leading into the top collecting main, one such main being provided along one side of each bench. Each top offtake has a liquor-spray and a dish-valve, the latter being described in detail, under " Seal and Liquor Sprays," later.

Each chamber is also fitted with a special cast-iron bottom gas offtake forming part of the bottom castings. This secondary gas offtake is so designed that it only comes into play during the first few hours of the carbonizing cycle, when gas evolution is exceptionally rapid. Each bottom offtake leads into a bottom collecting main, there being two such mains for each bench. Each bottom offtake has a vertical dip-pipe which is sealed in liquor in the collecting main. When the pressure in the chamber exceeds the amount of the seal, the bottom offtake automatically comes into operation. The bottom of each dip-pipe has a number of inverted **V**-notches so that the gas can pass out steadily, rather than in " gulps."

Each bottom collecting main is provided with a central cleaning well, also with an adjustable weir overflow, whereby the height of the liquor in the main and the depth of the seal on the bottom offtake dip-pipes can be adjusted.

By eliminating excessive bottom pressure in the chambers not only is gas saved, but maintenance costs of brickwork and ironwork are materially reduced.

The position of the bottom offtake in relation to the chamber is so arranged that no pitching-up ever occurs, and it is the invariable experience that every bottom offtake is always moist internally.

The top and bottom collecting mains are connected together by means of one vertical gas uptake rising from the centre and two vertical liquor downtakes leading to the ends of each bottom main, the flow of liquor in the latter being towards the central cleaning well. Shown in Fig. 4.

From the respective centres of the two top collecting mains are led two foul mains, which are connected together within the house, the pressure in the foul mains being governed by a butterfly-valve working in conjunction with a modern type of gas pressure regulator, by means of which accurate control of the pressure at the chamber offtake pipes is obtained.

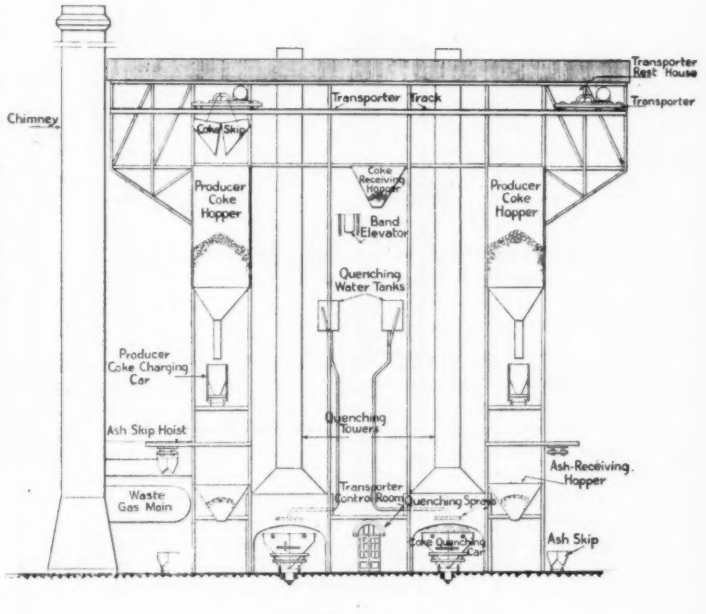


FIG. 3.

Chamber Bottom Doors and Operating Gear.

The bottom door of each chamber is carried, at eight points on its longitudinal centre line, by four cradles, or double hinges. These hinges are keyed to a heavy shaft which is supported by hangers attached to the underside of the door frame on one side, and are engaged by four latches keyed to a lighter shaft similarly supported on the other side.

Each cradle or double hinge is connected to lugs on the underside of the door by means of two eccentric levers, the latter being operated from floor-level by means of a wooden shaft, about 6 ft. long and 2 in. diameter, fitted with a short length of pipe at the upper end.

The eccentric levers serve to tighten or release the door.

The end levers first lift the whole length of the door into contact with the frame and then make a tight joint between the door and frame at each end. The mountings of the six intermediate eccentric levers are so designed that the above is accomplished without the door being bent in any way. These six levers, which are always

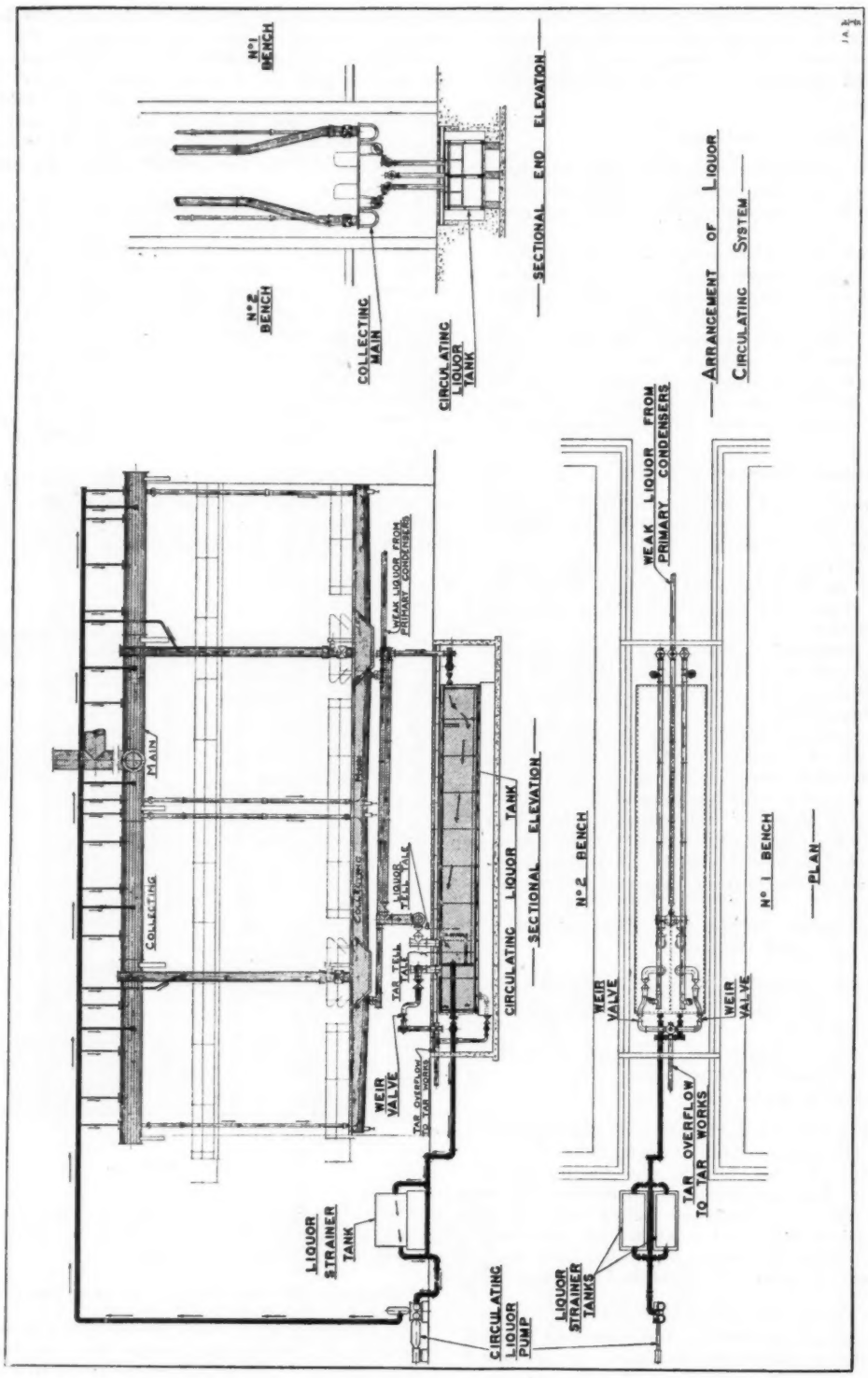


FIG. 4.

tightened last (and loosened first), are provided for making the joint between the door and the frame perfectly gas-tight at all points, in which connection the makers fit the doors to the frames so that the maximum clearance at any point between any door and frame, *before* full pressure is exerted by the eccentric, is less than 0·0015 in.

Each setting of six chambers is provided with a hydraulic ram for moving a horizontal rack backwards and forwards, the rack being the full length of the setting. Each door-shaft is provided with a pinion-wheel and a clutch, whereby the horizontal movement of the rack can be transmitted to rotational movement of any one door-shaft. By this means the chamber bottom door can be opened or closed, and the hinges can be held up clear of the latches when the latter are being operated. Each latch-shaft is fitted with a hand-lever, which is operated from the floor level and works all four latches simultaneously. Each hydraulic ram is operated by means of a short hand-lever, which is fitted with a spring-controlled plunger working on a notched quadrant and is attached to a conveniently situated and specially designed valve-box.

The materials of which the various parts of the chamber bottom castings, bottom doors, and operating gear are made have been carefully selected for their suitability. use being made of cast iron, cast steel, mild steel, and high-carbon steel.

Hydraulic Installation.

For supplying the hydraulic pressure to operate the chamber bottom doors, two steam-driven hydraulic

pumps are provided, one acting as a standby to the other. The pumps operate through an accumulator loaded to give a pressure of about 550 lbs. per sq. in.

Coke Quenching, Handling, and Storage Plant.

At the floor level beneath each line of chambers are provided rails, on which runs a coke skip chassis, each chassis being constructed with accommodation for two bottom discharging skips, each skip being of a sufficient size for holding the charge of coke from one chamber. Each chassis is connected to an electrically-driven winch-drum by means of a wire rope running on rollers in a trench fitted with hinged cover plates. The winch-drum motors can be operated by any one of a number of conveniently situated push-buttons.

At the end of each bench is a quenching tower containing spray pipes supplied with water from an overhead storage tank, the latter being replenished by means of an electrically-driven centrifugal pump which comes into action automatically each time the tank is emptied. The quenching tower is provided with a high steel-framed timber-lined shaft through which the steam rises and escapes to atmosphere above the chamber house. An underground tank, built of concrete and covered with easily removable reinforced concrete slabs, is provided for collecting the quenching water which passes out from the bottom of the coke skip into gulleys. This tank is of sufficient size to give ample settling time, and is, in addition, provided with grids at the inlet end and with screens at the end connected to the pumps.

At the top of the chamber house, just beyond the quenching towers and running parallel with the ends of the benches, is a track supporting two electrically-driven transporters, shown in Fig. 3. A transporter rest house is provided at each end of this track.

Suspended, by means of wire ropes, from the winch-drum of each transporter is a bale which can quickly be attached to any coke skip when the latter is in the hoisting position just beyond either quenching tower.

The electric motors for driving the transporters and working the winch-drums are operated by means of distance controllers which are situated in a small transporter control room built at ground level on to the end of the chamber house, midway between the two transporter hoisting positions.

Between the transporter rest houses and immediately beneath the transporter track are two producer coke storage hoppers, there being one hopper in line with the producers of each bench. Each of these hoppers is provided with one shoot for filling the electrically-propelled producer coke charging car provided at the top of each bench, and another shoot for filling lorries at ground level. One of the hoppers is provided with a third shoot leading to a temporary screening plant.

Midway between the two producer coke storage hoppers is a small receiving hopper, through which the small coke to be used for the chamber pads can be fed on to the band coal elevator leading to the shuttle band conveyor above the coal and coke pad storage hoppers.

Through this same receiving hopper the surplus coke is to be fed on to a band conveyor leading to the new coke screening plant which is in course of construction.

The three coke hoppers beneath the transporter track are all constructed of steel and lined with blue paving tiles.

The transporter track and the transporters are fitted with a number of limit switches, and the cable and wiring connections are so arranged that neither transporter can travel horizontally except when its bale is in such a position as to ensure the coke skip being at a safe height above the top of the coke hoppers, neither transporter can lower an attached skip or empty bale except when it is immediately above one of the three coke hoppers or one of the two hoisting positions above the coke skip track, either transporter can be used over the whole length of track between the two rest houses, and the two transporters when both in use on this common track cannot possibly collide.

Ash Handling Plant.

At the same end of each bench as the producer coke hopper, but at a lower level, is situated an ash skip hoist and an ash receiving hopper, the former being used to pick up the ash skips (which run on rails continued along the front of the producers at ground level) and empty the ash and clinker from these skips into the receiving hopper. Each receiving hopper is provided with a shoot for loading lorries.

Waste Heat Recovery and Fuel Economy.

In designing the plant careful consideration was given to fuel economy.

As has already been mentioned, the waste gases leaving the chamber combustion flues pass down through the recuperators and thence up into outside circular steel-cased waste gas mains which are lined with firebricks and insulating material. One such main is provided for each bench, and the two mains are connected together by a third and similar main which is situated at one end of the benches. This third main terminates in branch flues connected to the firebrick-lined steel chimney and to two waste heat boilers.

Heat-resisting dampers, operated by hand-winches, are provided so that the chimney or either boiler can be worked.

Each of the boilers is capable of dealing with all the waste gases from the first section of the plant.

A third boiler is being added with the second section, giving one spare boiler for the completed plant.

The boilers are of the horizontal fire-tube type and of special design.

The induced draught fans are steam-turbine driven, the exhaust steam being utilized for heating the feed water, the latter consisting of the softened water which has been pumped through the setting hollow tie-rods and which has consequently already been warmed.

Heat economy is also effected by the provision of efficient heat insulation for the settings, waste gas mains, and all steam piping.

Lift.

A passenger lift situated in the chamber house, near the transporter control room, gives quick access to all working levels.

Gauges, Recording Instruments, &c.

In order that complete operating data could be obtained, a number of gauges and recording instruments were fitted on the plant. Amongst these may be mentioned a draught gauge with independent connections to the two waste gas mains, an indicating gauge for the gas pressure regulator on the foul main, seven thermometers in connection with the waste heat boilers, and a complete thermograph outfit for recording the temperatures of the waste gases at the inlets and outlets of the waste heat boilers.

Pump and Boiler House.

The pumps for the various services are housed in the same building as the waste heat boilers separated by a parting wall with an opening for the pumpman who attends the waste heat boilers.

The position of the pump and boiler house is shown on the general diagram, Fig. 2.

The pumps include:—

3 horizontal tie-rod water pumps (steam).
3 vertical boiler feed water pumps (steam).
2 horizontal circulating liquor pumps (steam).
2 horizontal hydraulic pumps (steam).
2 vertical centrifugal direct driven pumps for quenching water (electric) with immersed pump end.
2 horizontal tar pumps (electric).
2 centrifugal pumps for general service water (electric).

The two electrically-driven winches by which the hot coke skips are hauled in and out are also housed in the pump house.

Gas Testing House.

The installation is provided with the following apparatus for recording the quality of the gas as made, with a time lag of only six minutes:—

Fairweather recording calorimeter.
Gas volume recorder.
2 Electroflo CO_2 recorders.
Gravitometer.
Vacuum recorders.

One of the CO_2 recorders is on the gas stream, and is particularly useful in connection with steaming efficiency; the second CO_2 recorder can be connected to any of the producers by a system of lead piping connected to silica tubes in the producer gas uptake flues.

The recording and sampling apparatus is housed in a small building behind the primary condensers, the recording apparatus being on the upper floor, and the sampling apparatus, consisting of a motor-driven exhauster, a condenser, a scrubber, and a purifier, being on the ground floor.

Liquor Circulation and Tar Separation.

Liquor circulation through the sprays in the top gas offtakes is of vital importance, and it is essential that the liquor should be tar and dust free.

For this purpose a rectangular cast-iron separating tank, 42 ft. long, 8 ft. wide, and 4½ ft. deep, is provided. This tank is divided longitudinally into two sections, so that one section can, when necessary, be cleaned out, while the other section remains in action. The tank, for convenience, is sunk just below the ground level, midway between and parallel with the two benches, and is covered at floor level with concrete slabs which can easily be lifted to give access to any of the manhole covers on the tank. On Fig. 4 is shown a diagram of the tank, and the weir method of tar separation is illustrated.

Condensed tar and liquor leaving the collecting mains flow down to this separating tank; tar containing less than 5 per cent. liquor overflows continuously at one end.

The liquor entering the pipe leading to the pump suctions is thus practically free from tar, but, to ensure the removal both of the final traces of tar and of all extraneous material which might block the sprays, the liquor is also passed through filter tanks in duplicate situated between the separating tank (shown in the general diagram, Fig. 4) and the pumps. These filter tanks contain a series of wire mesh screens which are periodically changed and cleaned.

No attempt is made to cool the liquor, which reaches the sprays at a temperature of about 70° C.

Electrostatic Detarrers.

A plant for the electrical precipitation of tar has been fitted in connection with the installation; a system of tar fog removal with which the author was much impressed during a recent visit to the United States.

In order to effect the earliest separation of tar and liquor and prevent the absorption by liquor of tar acids, with a view to improving the effluent liquor from the sulphate plant—the electric precipitator or chamber treaters—are erected between the benches of the first and second sections of intermittent chambers in order that the gas leaving the governor or the outlet of the collecting mains passes immediately through the detarrers; the short length of main leading to the detarrers and also the detarrers are lagged, so that the gas is treated at a temperature above the dew point—thus minimizing condensation of liquor with the precipitated tar.

High-tension direct current of some 40,000 volts is necessary for electrical precipitation, and is obtained from D.C. current generated on the works through an alternator, transformer, and rectifier.

Two types of rectifiers, mechanical and static, are used for this purpose; the Simon-Carves plant with static rectifiers was adopted owing to the fact that there were no moving parts or sparking in the electrical equipment, and for this reason was considered more suitable on a gas-works; it was estimated that maintenance would probably be lower with no moving parts.

The electrical transformer and rectifying plant is housed in a building designed for the purpose in the vicinity of the carburetted water gas plant, and the equipment, in addition to supplying high-tension direct current to the coal gas treater, also supplies current for a carburetted water gas treater with a capacity of 7 million c.ft. per day.

Detarrers or Treater Chambers.

The treater chamber consists of a rectangular steel vessel approximately 9 ft. by 5 ft. by 26 ft. high, built in four sections, of which the three bottom sections form the gas chamber, and the top section houses the lead-in and supporting insulators, and supports the gridwork from which hang the discharge electrodes consisting of lead-covered wires.

In the middle sections, 91 6-in. diameter weldless steel tubes, 9 ft. long, fitted in a tube plate, are housed; the discharge electrodes hang centrally in these tubes, and are kept taut by means of weights; gas enters at the top of this section, passes down the outside of the tubes and up through them, where it is subjected to the electrical discharge, when the tar particles are attracted to the inside of the tubes, burst, flow down, and drop off at the bottom of the tubes into the lower section of the treater, which is fitted with a sloping base, from which tar is run off through seals. In Fig. 5 a section of detarrer is shown.

OPERATION OF THE PLANT.

Labour.

With the first section of the plant only at work, comprising 8 settings of 6 chambers each—*i.e.*, 48 chambers—6 men per 8-hour shift are required, their respective duties being as follows:—

2 *Top Men per Shift.*

Weigh coal charges and charge chambers, attend to top gas offtake pipes, liquor sprays and tie-rod water supply, weigh and feed coke to the producers.

1 *Bottom-Door Man per Shift.*

Opens and closes chamber steam inlet valves, opens, cleans, and closes chamber bottom doors, places coke skip in position, and attends to bottom gas offtake pipes.

1 *Coke Transporter Man per Shift.*

Takes skip with hot coke from bottom-door man, places under quenching tower, quenches coke, attaches transporter bale to skip, and controls hoisting of skip, travelling of transporter, discharging of coke into coke hoppers, and return of empty skip to chassis.

2 *Firemen per Shift.*

Attend to cleaning of the three grates of each of the eight producers, one producer per setting.

In addition, there are two men, on day-work only, who carry out sundry duties in connection with flue cleaning, scurfing chambers, &c., &c.

Total Labour for the First Section.

20 men per 24-hour day. With a gas output of 5 million c.ft. per day the labour works out at four men per million c.ft. of gas made.

With the second section at work, 14 extra men will be required:—

3 top men (1 per shift).
3 bottom-door men (1 per shift).
6 firemen (2 per shift).
2 additional men on day-work only.

14 total.

This will make a total of 34 men for the production of 10 million c.ft. of gas per day—*i.e.*, 3·4 men per million.

Chamber Charging.

Coal is fed, by hand-lever, from any of the shoots beneath the overhead storage hoppers, into the charging hopper on the electrically-propelled chassis.

As mentioned previously, mounted on the same chassis is a separate compartment for small coke (also supplied from an overhead storage hopper) feeding a small charging hopper, the capacity of the latter being 5 cwt.

The coal charge, which has an average weight of 3·6 tons, is weighed by an "Avery" weighing and totalizing machine, on which the coal charging hopper is slung.

The full charging car is placed in position over the two open charging holes of the chamber, and the measured charge of small coke is first dropped in. This charge of small coke forms a protecting pad covering the bottom door and castings upwards for about 12 in., and prevents coal from lying in the unheated portion of the chamber below the bottom of the silica belt. Small coke is used

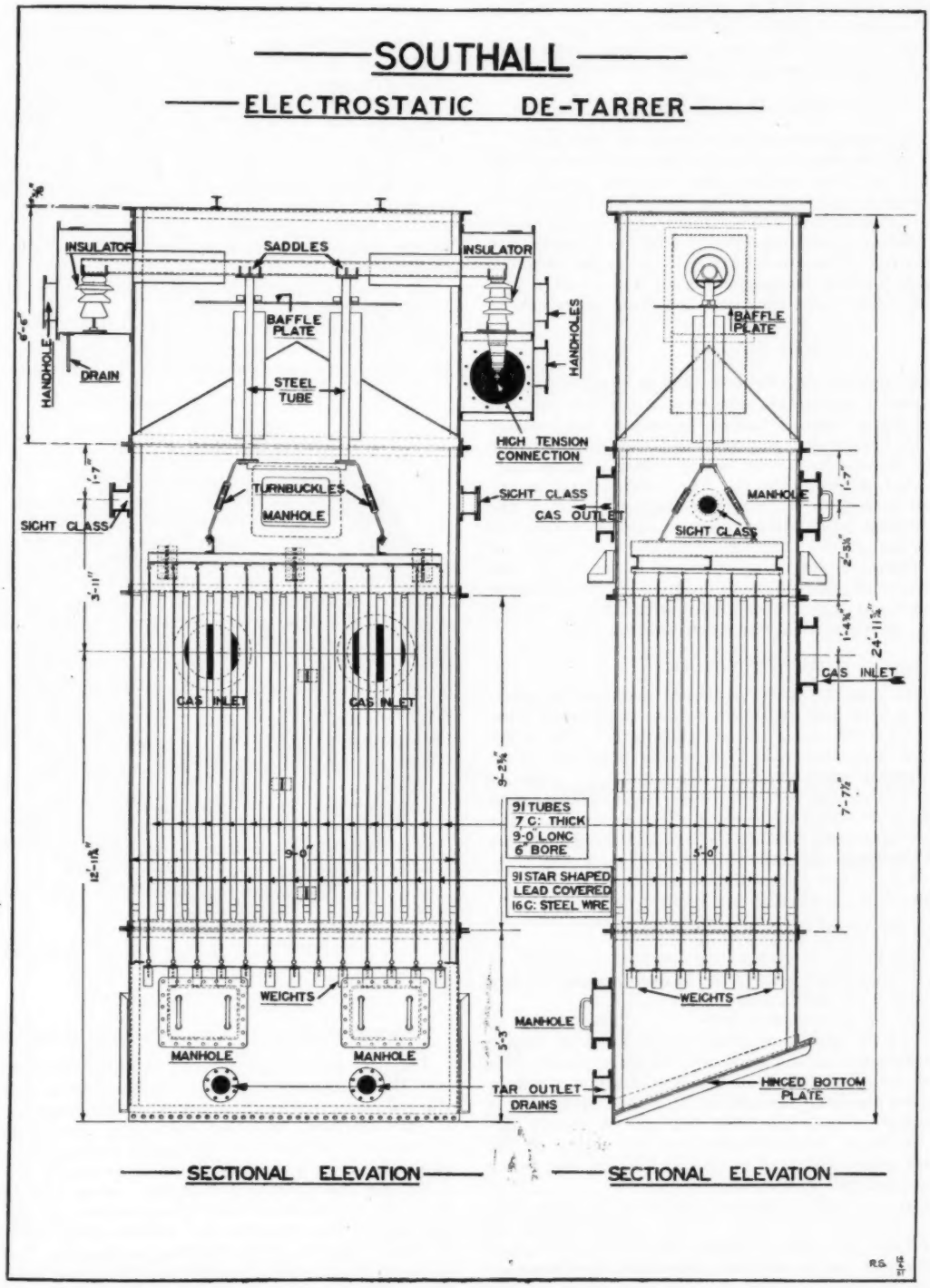


FIG. 5.

for this pad, in preference to breeze, to avoid the possibility of undue resistance being offered to the passage of gas towards the bottom offtake.

During coal charging, which is carried out immediately after the coke pad has been dropped, and takes 30 seconds, the hinged lid of the top offtake pipe is left open to provide a vent for the air displaced from the chamber by the incoming coal. Above the open offtake is placed a movable stack-pipe fitted with rollers and mounted on rails continued throughout the length of the bench, one stack-pipe being provided for each setting of six chambers.

Top Offtake Seals and Liquor Sprays.

The top gas offtake pipe of each chamber is kept sealed, from the time of discharging until the chamber has been recharged, by means of a very simple and effective device. This consists of a cast-iron dish, which is hinged inside a cast-iron box forming part of the offtake connection, and is operated by means of a lever fitted to a spindle passing through a gland. When placed in a horizontal position this cast-iron dish covers the extension of the arch pipe, the latter being automatically sealed to the depth of 2 in. by the circulating liquor from the spray in the top of the arch pipe, the surplus liquor passing into the top gas collecting main and thence to the liquor downtake.

Liquor spraying is of vital importance, as the temperature of the gas leaving the chambers varies from 500° to 600° C. The gas is cooled to below 100° C. by the hot liquor sprays, whereby the formation of pitch is entirely prevented and all ammonium chloride is kept in solution.

The liquor circulating system feeding the sprays is

maintained at about 25 lbs. pressure, and the volume circulated is about 50 gallons per 1000 c.ft. of gas made.

No trouble whatever has been experienced from pitch or thick tar since the installation went to work.

Chamber Discharging.

When discharging a chamber the steam inlet valve is closed and the top doors are opened, the coke car is placed in position, and the bottom door is then opened by hydraulic power, the coke falling immediately from the chamber. The coke car is then drawn along by the winch (the latter being electrically operated by the bottom man pressing any one of the push buttons), and is placed under the quenching tower for quenching by means of a predetermined volume of water supplied from an overhead tank.

Coke Handling.

After coke quenching, the coke car is handled by the coke transporter attendant, who moves it a few feet out of the quenching tower, attaches the skip to the hoisting bale, and then operates the overhead electrically-driven transporter winch from the small control room centrally situated at ground level. The hoisting and travelling, which is out of his sight, is controlled with the aid of a system of coloured electric lamps, which are situated in the control room and indicate the position of the skip, thus enabling the operator to discharge the coke into any of the overhead hoppers. To discharge the skip when in position over a hopper the skip is lowered about 1 ft., which causes it to open automatically.

Feeding Producers.

Unscreened coke from the overhead producer hoppers, one of which is in line with each bench, is dropped from a bottom shoot into a producer charging car, the latter consisting of a bottom discharging skip mounted on an electrically propelled chassis. The producer coke is weighed in the car on the " Avery " automatic weigher and totalizer provided at the end of each bench. The car runs on light rails laid, at the coal charging level, on top of the producer and recuperator brickwork.

The producers are all re-filled every four hours, one skip of coke being sufficient for each.

Producer Cleaning and Working.

Every step-grate is cleaned at regular intervals of eight hours, one of the three grates of each producer being cleaned every $2\frac{1}{2}$ to $2\frac{3}{4}$ hours.

The dead ashes, together with any clinker lying at the bottom of the grate, are removed first. Any clinker which has formed on the producer walls or columns is then sliced away and broken up, the firemen working with a clinker-bar from bottom to top of the grate. This broken clinker is not removed since, as it slowly descends, it becomes further broken by the action of the moist steam admitted, and assists in keeping the lower part of the fuel bed porous.

The steam is admitted through perforated pipes, one of which lies along each side of the sloping length of each grate, the amount of steam used to ensure good working combined with easy cleaning of the fires depends on the amount and nature of the ash in the fuel, and is usually about 50 lbs. per 100 lbs. of dry coke used.

When using unscreened coke as made by the plant, and without resort to use of the injectors, the producers have proved capable of gasifying over 5 tons of coke per 24 hours each—this being over 10 lbs. per hour per square foot of grate-area—at the same time giving an excellent quality producer gas, of which the following figures are typical:—

CO_2 = 5·6 per cent., CO = 27·6 per cent., H_2 = 11·5 per cent.

Gross C.V. = 125 B.Th.U. per c.ft.

A typical chart showing the CO_2 in producer gas is illustrated (Diagram 1).

Apart from any pieces of unburnt coke, which can easily be separated by hand-picking, the amount of carbon in the ashes and clinker removed is small, a test carried out over a week giving a figure of 71·9 per cent. of ash by weight on the dry basis.

Chamber Scurfing Routine.

The chambers are scurfed once in every 12 days, one charge in 24 being missed for this purpose. Scurfing is a very simple operation, the bottom and top doors being left open, and each charging hole being kept partially covered by a plate to allow just sufficient air to flow upwards (by the chimney effect of the hot chamber) for a period of 10 to 12 hours, when the deposited carbon is completely burnt off. Care is taken to prevent excess air flowing through the chamber, as this might cause too great a skin temperature at the beginning of the scurfing period and undue cooling of the refractory material later. Sometimes it is necessary to insert a diverting plate to ensure that sufficient air will travel up the ends. No tools are used for the scurfing.

After scurfing, the chamber bottom brickwork is brushed over with a silica cement wash, and the joints round the top door frames are grouted with the same material.

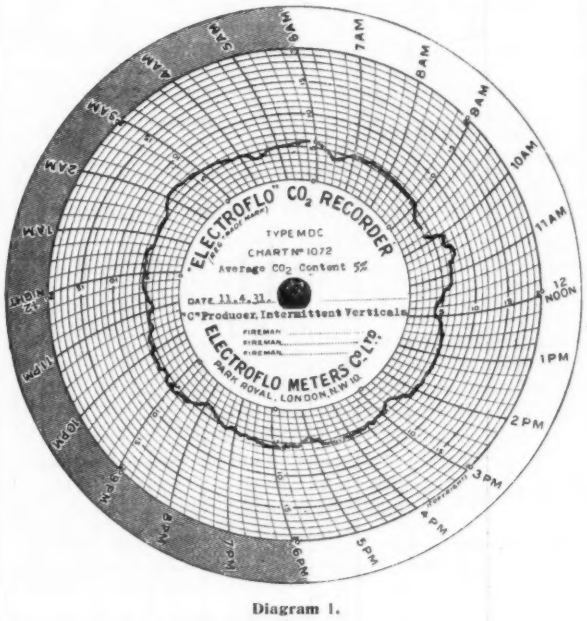


Diagram 1.

CARBONIZING RESULTS.

Determination of Carbonizing Temperatures.

The first consideration when the plant was put to work was the determination of the temperatures required for the guaranteed coal throughput of 300 tons per 24 hours to be obtained, *together* with the production *in the chambers* of sufficient *good quality* water gas for diluting the coal gas to a calorific value of 510 B.Th.U.

During the preliminary stages, when one bench was at work and the other was being heated up, the working chambers were maintained with average temperatures of about 1320° C. in the bottom combustion flues ranging down to about 850° C. in the top flues, the charges being left in the chambers for 14 hours total and steam during the last two hours. The resulting coal throughput and thermal yield were both below the guaranteed figures.

After the second bench had been put to work the temperatures on both benches were gradually increased to an average of 1370° C. at the bottom ranging down to about 920° at the top, the latter figure being increased shortly after to about 960° C. and the former reduced to 1360° C. These conditions of temperature allowed of the chambers being worked to a 13-hour schedule (this giving the guaranteed coal throughput) with steaming during the last two hours, and at the same time resulted in the thermal yield being increased to the guaranteed figure, the gross calorific value of the gas being maintained at 505 to 515 B.Th.U.

Subsequently, by increasing the heat input and simultaneously altering the schedule to a faster cycle of working with earlier steaming of the charges, the top temperatures were increased to an average of 1000° C., this figure being obtained with average bottom temperatures

not above 1380° C. Under these conditions the charges, which had an average weight of 3·6 tons, were well burnt off within 10 hours, thus allowing each chamber to be recharged every 12 hours, each charge being steamed throughout the last two hours. The guaranteed figures for the throughput of coal and thermal yield of gas at 510 B.Th.U. were thus both exceeded.

Temperatures averaging 1360°-1380° C. in the bottom flues, ranging down to 1020°-980° C. in the top flues, were maintained throughout all those tests during which the charges were burnt off in 10 hours and steamed from the tenth hour onwards, any increase in the interval between successive chamber rechargings and consequent reduction of coal throughput during such tests being due to the duration of the steaming period being increased for the purpose of increasing the production of water gas, reducing the calorific value of the mixed gas, and increasing the thermal yield per ton of coal.

Guarantee Test.

The contractors' guarantees, under penalties, given for a test period of 28 consecutive days, using Durham coal having a combined moisture and ash content not exceeding 8 per cent., are set out in the following table, together with the actual results obtained.

Throughout the guarantee test the greatest care was taken to ensure accurate results.

The make of gas was measured in a new Parkinson station meter, check tested immediately before the test, and again at the termination of the test, and found to be perfectly correct, and hourly readings were made of the barometer and of the temperature and pressure at the meter, the make of gas being corrected daily to 60° Fahr. and 30 in. mercury.

The calorific value of the gas was determined, after purification, by a Fairweather recording calorimeter which was checked every four hours by means of a Boys calorimeter.

Coals were sampled continually throughout the whole period and tested for moisture and ash.

All fuel to producers and all grades of coke and breeze made for sale were weighed, sampled, and tested for moisture content separately.

Twenty-Eight Day Official Guarantee Test.

—	Contractors' Guarantees.	Actual Results.
Coal carbonized per 24 hours, tons	300	324·8
Total moisture and ash in coal, per cent.	8	10·45
Gas made per 24 hours—		
C.ft.	4,590,000	5,073,000
Therms	23,409	25,892
Gross calorific value of gas—		
B.Th.U. per c.ft.	510	510·4
Gas made per ton of coal as used, containing 10·45 per cent. moisture and ash—		
C.ft.	..	15,617
Therms	..	79·71
Gas made per ton of coal, containing 8 per cent. moisture and ash—		
C.ft.	15,300	16,043
Therms	78	81·88
Fuel to producers, dry coke—		
Lbs. per ton of coal carbonized	382	317
Lbs. per 100 lbs. of coal carbonized	17	14·15
Equivalent evaporation in one waste heat boiler and superheater, reckoned "from and at 212° Fahr."—		
Lbs. of steam per lb. of dry fuel used	2·73	2·45

The above results were obtained with an average of 2 of the 48 chambers, throughout the 28 days, out of commission for scurfing.

From the above results it is seen that the contractors' guarantees of the carbonizing plant capacity and thermal efficiencies have been very considerably exceeded.

The results obtained during the 28 days guarantee test and the working conditions were carefully recorded and are conveniently shown on the following graph, Diagram 2, in which the daily variations are indicated.

They were also recorded for each of the four weeks, and as the weekly carbonizing results appear to be of interest, they are shown separately in the following table.

Weekly Results of Official Test on Woodall-Duckham Intermittent Vertical Chambers.

Items.	Contractors' Guarantees.	1st Week Results.	2nd Week Results.	3rd Week Results.	4th Week Results.	Average Results.
Coal carbonized per 24 hours, tons	300	320·0	322·3	326·7	330·3	324·8
Moisture *plus* ash in coal, per cent.	8·0	9·38	10·63	11·25	10·52	10·45
Gas made per 24 hours—						
Thousands of c.ft.	4,590	4,981	5,015	5,042	5,254	5,073
Therms	23,409	25,456	25,650	25,683	26,777	25,892
Gross calorific value of gas—						
B.Th.U. per c.ft.	510	511·1	511·4	509·3	509·7	510·4
Gas made per ton of coal as charged—						
C.ft.	..	15,566	15,562	15,433	15,906	15,618
Therms	..	79·55	79·59	78·61	81·07	79·71
Gas made per ton of coal, containing 8 per cent. moisture, *plus* ash—						
C.ft.	15,300	15,802	16,020	16,000	16,353	16,043
Therms	78	80·76	81·93	81·49	83·35	81·88
Fuel to producers, dry coke—						
Cwt. per ton of coal carbonized	3·4	2·90	2·73	2·85	2·85	2·83
Lbs. per 100 lbs. of coal carbonized	17	14·50	13·65	14·25	14·25	14·15
Steam to chambers—						
Weight admitted, per cent. on coal carbonized	..	6·0	7·5	8·7	8·8	7·8
Chamber heating flue temperatures—						
Average tops, ° C.	..	1,005	990	975	990	990
Average bottoms, ° C.	..	1,375	1,380	1,375	1,370	1,375
Composition of gas made—						
CO_2, per cent.	..	2·0	2·6	2·7	2·8	2·5
O_2, ,,	..	0·3	0·2	0·3	0·3	0·3
C_nH_m, ,,	..	2·3	2·4	2·5	2·4	2·4
CO, ,,	..	14·9	14·6	14·6	14·6	14·7
H_2, ,,	..	51·6	50·9	50·6	51·1	51·1
CH_4, ,,	..	23·7	23·7	23·6	23·6	23·6
N_2, ,,	..	5·2	5·6	5·7	5·2	5·4

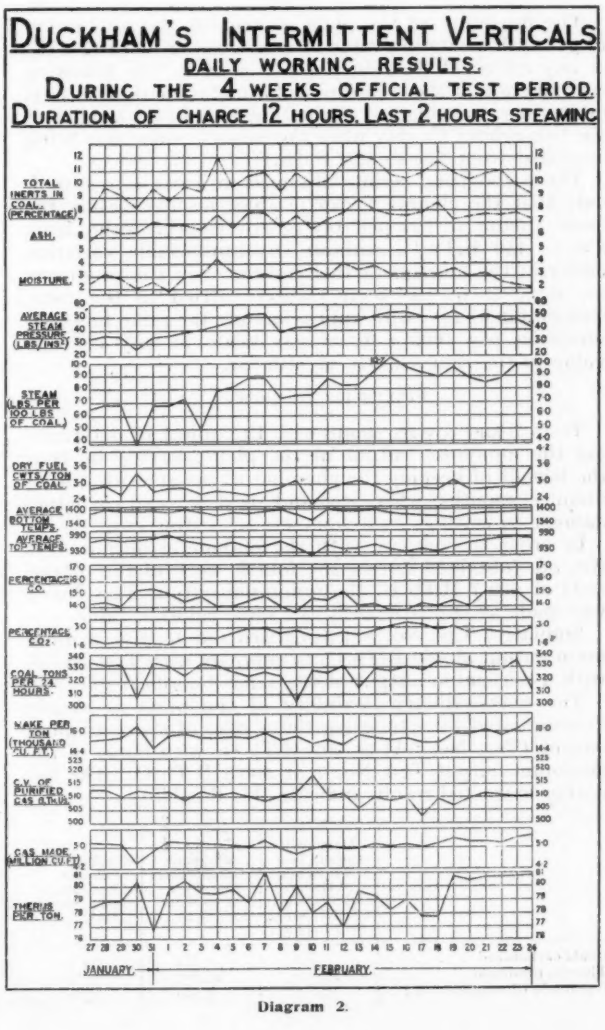


Diagram 2.

Particulars of the chamber steaming, which was varied throughout the test to prevent appreciable variations of calorific value, are also given, together with the average temperatures in the chamber heating flues and the average analysis of the gas for each week.

The most interesting results to compare are those obtained during the first and fourth week.

The high percentage of CO and the low percentage of CO_2 in the gas for the first week correspond with the highest top temperatures and the lowest percentage of steam admission to the chambers, and indicate that the highest steaming efficiency, together with the highest quality water gas, was obtained during this week.

The higher thermal yield per ton of coal obtained during the fourth week corresponds with a lower percentage of CO and a higher percentage of CO_2 in the gas, and indicates the value of increased steaming, even at a slightly reduced efficiency.

It was felt by the author that the figures obtained during the guarantee test were far from exhausting the possibilities of the plant; a number of tests were accordingly carried out under varying conditions, and the results are shown in tabular form, which in order to facilitate comparison of corresponding items in different columns, has been arranged as far as Tests Nos. 1 to 6, to demonstrate the effects of a progressively extended steaming period; included in Tests Nos. 1 to 6 are the results of the four weeks' guarantee test and the fourth week in which the maximum production of the test was obtained.

To those engineers whose undertakings supply gas of 460 or 450 B.Th.U., the results of Tests Nos. 4 and 6 should be of interest, while to those who find it advisable to generate water gas in a separate plant, necessitating higher quality coal gas, the results of Test 1 (at a calorific value of approximately 550 B.Th.U.) should appeal.

Flexibility of Calorific Value.

The flexibility of the plant as regards the production of gas with a calorific value of either 550 or 450 B.Th.U., or any intermediate value, is well shown; the following reproduction of the recording calorimeter chart, Dia. 5, is interesting, showing the gradual increase in the quality of gas throughout the day when the calorific value was being increased from 450 to 550 B.Th.U.

The carbonizing results obtained in Tests 1 to 6 indicate that the chambers can produce approximately the same volume of gas per day at any calorific value from 550 to 450 B.Th.U. without any appreciable variation either of the amount of fuel consumed in the producers *per day*, or of the temperatures carried in the combustion flues—*i.e.*, with approximately the same fuel consumption per 1000 c.ft. of gas made at any calorific value in the range above mentioned.

Flexibility of Output.

Tests 7 and 8 were made with the object of determining the minimum output of the plant, having in view the benefit of keeping the chamber ovens at work during summer months when demand is low, and avoiding damage to settings and chambers by letting out.

In order to compare with the maximum output Test No. 3A (obtained during the fourth week of the official test) at 509·7 B.Th.U. the minimum output Test No. 7 was made at approximately the same calorific value.

Similarly, Test No. 8 was carried out to give a minimum output at 460 B.Th.U. to compare with Test No. 5, with a maximum output of the same calorific value.

The extraordinary flexibility of the plant is clearly demonstrated by comparing the results of the maximum output (Test No. 3A) at 509 B.Th.U. with those of the minimum output Test No. 7 at 506·5 B.Th.U. The following extracted results indicate this flexibility:—

—	Maximum Output Test No. 3A per 24 Hours. 4th Week of Official Test at 509·7 B.Th.U.	Minimum Output Test No. 7 per 24 Hours at 506·5 B.Th.U.	Flexibility of Output. Percentage Reduction on Maximum.
Coals carbonized	330	214	35·2
Therms produced	26,777	16,765	37·4
Gas made (thousands c.ft.)	5,254	3,310	37·0

During the minimum output Tests Nos. 7 and 8, variation in calorific value did not exceed 5 per cent. above or below the average, as will be seen from the following reproductions of the calorimeter charts during these two tests, Diagrams 3 and 4. Another typical chart of the calorific value during the official test (No. 3) is shown in Diagram 6.

To obtain the reduced output, the amount of fuel used in producers was reduced to suitably lower the temperatures in the chamber heating flues; with such conditions the coal charge took from 12 hours to burn off and the steaming period was increased to 7 and 8 hours. With this reduction it is interesting to note that the fuel consumption per ton of coal carbonized was lower in the minimum output test than that in the corresponding maximum output tests, thus:—

—	Dry Fuel Consumption per Ton of Coal Carbonized.
	Cwt.
Maximum output Test 3A at 509·7 B.Th.U.	2·85
Minimum ,, Test 7 ,, 506·5 ,,	2·62
Maximum ,, Test 5 ,, 459·6 ,,	3·33
Minimum ,, Test 8 ,, 460·5 ,,	3·16

There are two noteworthy features that have given the greatest satisfaction with this plant:

(1) The low percentage of nitrogen in the gas made which has not exceeded 5·4 per cent. over the wide range of conditions of the first six tests.

(2) The high steaming efficiency, particularly evident in Tests 1, 2, 3, and 4, in which a high percentage of CO in the gas is obtained with comparatively low percentage of steam used by weight of coals carbonized.

—	Percentage Steaming.	CO_2 Per Cent.	CO Per Cent.	N_2 Per Cent.
Test 1	3·1	1·7	10·3	5·4
,, 2	6·5	2·1	13·8	5·2
,, 3	7·8	2·0	14·7	5·4
,, 4	10·3	2·6	16·4	5·4

The following table shows the results obtained during the various tests, and the conditions under which they were carried out; owing to the limited time available before the preparation of this paper, some of the tests had to be confined to a period of from two to seven days.

The table showing the predominating coals carbonized during all tests, together with their proximate analysis, follows the carbonizing table.

Steam Decomposition.

The fundamental advantage that the vertical retort or chamber, whether of the continuous or intermittent type, offers over other forms of carbonization is the ease with which it lends itself to water gas generation; a record is therefore submitted in graphic form of some observations made on steam decomposition, which should prove interesting. Whereas in the "continuous" type the manufacture of coal gas and the generation of water gas proceed simultaneously, in the "intermittent" it is a two-stage process, as steam is not admitted to the chamber until carbonization has been completed. A depth of about 19 ft. of incandescent coke is available in these intermittent chambers for water gas reaction. Virtually, each chamber during its steaming period is a water gas generator, the temperature of which is externally maintained at or near the maximum by means of the combustion of producer gas in the chamber flues, thus permitting the continuous generation of water gas as opposed to the characteristic intermittency of a water gas plant; it is therefore to be expected that the efficiency of steam decomposition in these chambers should be equal to that of a water gas plant generator.

The chief factors affecting steam decomposition are temperature and the reactivity of the coke; since these vary from chamber to chamber, it would be extremely difficult to make an absolute assessment of the rate of water gas production in each of the 48 chambers during

Table of Results under Varying Conditions.

Item.	Woodall-Duckham Intermittent Vertical Chambers.									
	—	Steaming—Constant Pressure—Guarantee Con.	Guarantee Test.	Guarantee Test, 4th Week.	—	—	—	Minimum Output at about 510 C.V.	Minimum Output at about 450 C.V.	Yorkshire Coal.
Test Number	1.	2.	3.	3a.	4.	5.	6.	7.	8.	9.
Calorific value of gas, B.Th.U.	549·2	520·2	510·3	509·7	490·4	459·6	450·7	506·5	460·5	511·1
Period of steaming, hours	1	2	2	2·4	3	5	6	4	8·3	2
Period of test, days	4	7	28	7	4	3	6	6	2	7
Coal carbonized per day, tons.	344·4	327·3	324·8	330·3	301·4	265	248	214·2	194·3	307·5
Coal carbonized per chamber per day, tons	7·18	6·82	6·76	6·88	6·28	5·52	5·17	4·46	4·05	6·41
Duration of charge, hours	11	12	12	12	13	15	16	18	19·6	12
Percentage of moisture in coal	2·29	2·5	3·07	2·9	2·84	2·90	2·77	3·56	3·39	2·82
Percentage of ash (wet basis) in coal	8·18	7·2	7·38	7·6	7·83	7·71	7·16	7·72	5·76	4·73
Percentage total inerts in coal	10·47	9·7	10·45	10·5	10·67	10·61	9·93	11·28	9·15	7·55
Make of gas per day, thousands c.ft.	4,674	4,993	5,073	5,254	5,148	5,149	5,175	3,310	3,791	4,869
Make of gas, per chamber, per day, c.ft.	97,375	104,021	105,687	109,458	107,250	107,271	107,813	68,958	78,990	101,437
Make of gas, per ton of coal carbonized, c.ft.	13,573	15,255	15,617	15,905	17,080	19,430	20,867	15,456	19,516	15,831
Therms made per day	25,670	25,974	25,891	26,777	25,249	23,665	23,324	16,765	17,459	24,884
Therms made per charge	269	285	293	291	309	329	346	279	320	271
Therms made per chamber, per day	534·8	541·1	539·4	557·8	526·0	493·0	485·9	349·2	363·7	518·4
Therms made per ton of coal carbonized	74·50	79·36	79·71	81·10	83·77	89·31	94·05	78·29	89·87	80·91
Therms made per ton of coal carbonized, 8 per cent. inerts basis	76·50	80·85	81·88	83·36	86·10	91·90	96·02	81·19	90·95	80·52
Percentage of steam on coal carbonized	3·1	6·5	7·8	8·7	10·3	18·8	21·6	10·3	35·4	6·7
Percentage of steam decomposed, on steam admitted	68·5	..	57·0	..	55·6	46·0	48·0	..	..	85·6
Steam pressure in lbs. per square inch	33	40	43	47	42	49	47	23	52	34
Weight of carbon as CO and CO_2 in gas, per ton of coal carbonized	51	..	84	..	101	134	150	..	..	71·6
Dry producer fuel, cwt. per ton of coal	2·56	2·73	2·83	2·85	3·18	3·33	3·67	2·62	3·16	2·94
Dry producer fuel per therm, lbs.	3·75	3·78	3·86	3·83	4·14	4·06	4·28	3·61	3·89	4·07
Dry producer fuel per 1000 c.ft., lbs.	21·12	20·04	20·29	20·07	20·85	19·19	19·70	18·99	18·13	20·80
Dry coke for sale, cwt. per ton of coal	9·84	9·70	9·59	9·51	..	9·68	8·89	9·81	9·27	8·91
Coke for sale, 8 per cent. moisture basis	10·63	10·47	10·36	10·27	..	10·45	9·60	10·57	10·01	9·62
Dry breeze for sale, cwt. per ton of coal	1·00	1·02	1·31	1·28	..	0·91	0·98	1·06	1·01	1·10
Total dry coke and breeze for sale, cwt. per ton of coal	10·84	10·72	10·90	10·79	..	10·59	9·87	10·87	10·28	10·01
Total coke and breeze for sale (8 per cent. moisture basis), cwt. per ton	11·71	11·58	11·77	11·65	..	11·44	10·66	11·76	11·10	10·81
Equivalent evaporation in W.H. boiler and superheater, lbs. from and at 212° Fahr. per lb. of dry fuel	..	..	2·45	..	2·25	..	..	..	..	2·93
Temperature in chamber top flues, ° C.	966	976	974	981	1,004	986	996	859	859	1,006
Temperature in chamber bottom flues, ° C.	1,380	1,385	1,388	1,382	1,391	1,373	1,367	1,301	1,293	1,378
Analysis of gas—										
CO_2, per cent.	1·7	2·1	2·5	2·8	2·6	4·0	4·0	2·9	6·5	2·4
C_nH_m ,,	2·6	2·5	2·4	2·4	2·1	1·6	1·5	2·3	1·9	2·5
O_2 ,,	0·3	0·4	0·3	0·3	0·3	0·4	0·4	0·3	0·2	0·4
CO ,,	10·3	13·8	14·7	14·6	16·4	18·1	19·1	13·6	13·9	14·6
CH_4 ,,	28·5	24·3	23·6	23·6	21·9	19·7	18·9	24·0	20·4	24·3
H_2 ,,	51·2	51·7	51·1	51·1	51·3	50·9	50·7	50·6	51·2	49·4
N_2 ,,	5·4	5·2	5·4	5·2	5·4	5·3	5·4	6·3	5·9	6·4
Analysis of gas, c.ft. per ton—										
CO_2	231	320	390	445	444	777	835	448	1,269	380
C_nH_m	353	381	375	381	358	311	313	355	371	396
O_2	41	61	47	48	52	77	83	46	39	63
CO	1,398	2,105	2,296	2,322	2,801	3,517	3,986	2,102	2,713	2,311
CH_4	3,868	3,708	3,686	3,754	3,741	3,828	3,943	3,710	3,981	3,847
H_2	6,949	7,887	7,980	8,128	8,762	9,890	10,580	7,821	9,992	7,821
N_2	733	793	843	827	922	1,030	1,127	974	1,151	1,013
	13,573	15,255	15,617	15,905	17,080	19,430	20,867	15,456	19,516	15,831
Carbonizing wages (including operators referred to in previous pages), per therm	0·113d.	0·114d.	0·114d.	0·110d.	0·117d.	0·125d.	0·127d.	0·176d.	0·169d.	0·119d.
Carbonizing wages (including operators referred to in previous pages), per ton of coal	8·294d.	9·029d.	9·098d.	8·947d.	9·804d.	11·151d.	11·915d.	13·795d.	15·209d.	9·593d.

Durham Coals Carbonized During the Tests.

Proximate Analysis and Approximate Weights.

In the following table a list is given of the predominating Durham coals used during the tests (actually 29 varieties were carbonized).

Note.—Mixed consignments allocated to coal predominating.

Test Number	1.	2.	3.	3a.	4.	5.	6.	7.	8.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Proximate analysis on wet basis—									
Moisture	2·29	2·5	3·07	2·9	2·84	2·90	2·77	3·56	3·39
Volatile matter	31·4	32·7	32·2	32·7	31·7	31·3	31·9	30·5	32·7
Fixed Carbon	58·13	57·6	57·35	56·8	57·63	58·09	58·17	58·22	58·15
Ash	8·18	7·2	7·38	7·6	7·83	7·71	7·16	7·72	5·76
	100·00	100·0	100·00	100·0	100·00	100·00	100·00	100·00	100·00
Coals—									
Easington	9	..	..	9	2	..	11	..	..
Londonderry	16	7	1	19	..	6	..	18	25
Silksworth	31	..	13	..	..	..	..	..	..
Thornley	..	8	28	21	12	..	..	30	..
Wearmouth	25	6	13	6	22	..	49	2	75
Boldon	2	33	11	18	7	27	26	19	..
Holmside	..	..	3	12	3	..	..	7	..
New Pelton	..	..	..	..	6	34	8	..	..
Ryhope	17	..	25	6	5	..	..	..	..
Towneley Main	..	3	..	..	20	29	1	..	..
Lambton	..	14	..	4	15	..	..	..	..
Ravensworth Pelaw	..	..	..	..	..	..	5	24	..
South Hetton	..	29	..	5	..	..	..	..	..
Other coals, including Hebburn, Horden, &c.	..	..	6	..	8	4	..	..	..
Total	100	100	100	100	100	100	100	100	100

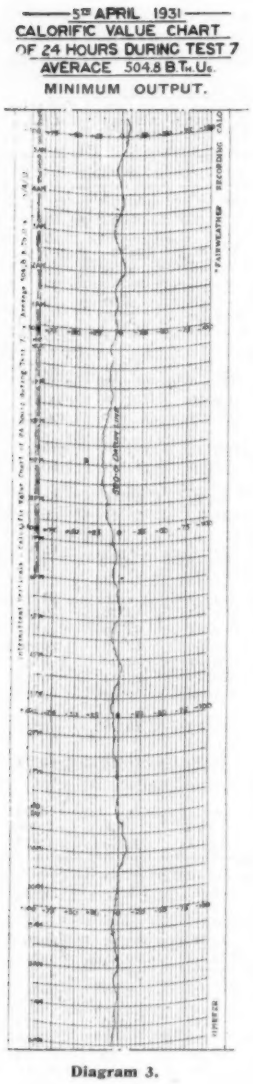


Diagram 3.

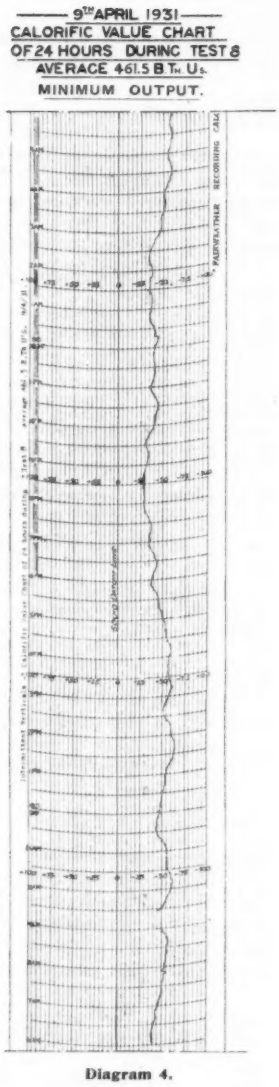


Diagram 4.

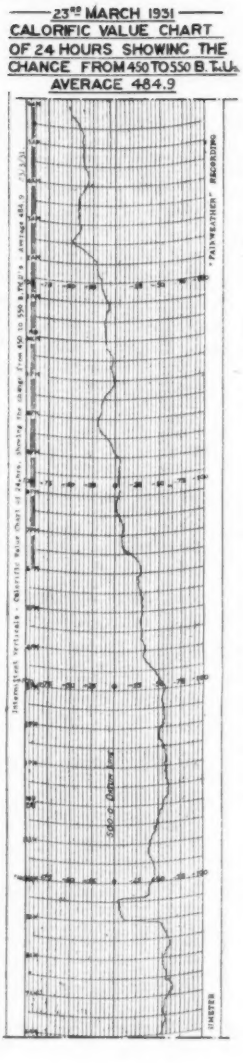


Diagram 5.

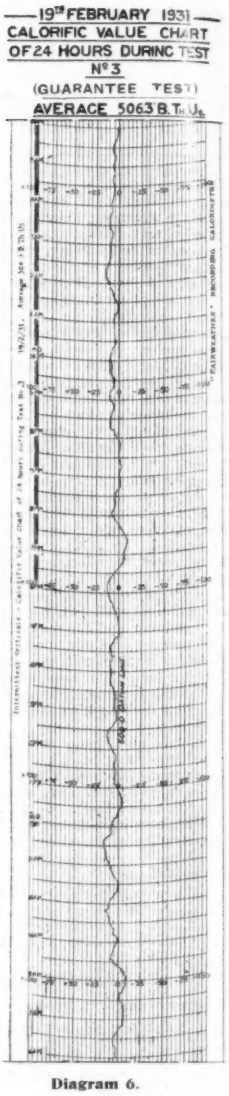


Diagram 6.

its steaming period. There is, however, a method which, disregarding thermal leakage, is *indicative only* of the efficiency of steam decomposition in a chamber during the steaming period.

Briefly, this evaluation depends upon a knowledge of the rate of steam input to the chamber, the determination of the amount of steam passing away undecomposed, and the analysis of the gas.

From these data, and making use of the two equations—

$$C + 2H_2O = CO_2 + 2H_2$$
$$C + H_2O = CO + H_2$$

the required evaluation can be made. By frequent repetition of these observations during the steaming of a chamber, the rate and quality of water gas generation can be calculated throughout this period.

Of the chambers tested during the first hour of steaming, whilst some showed a steam decomposition of 80% or more, others gave little more than 60%, the average being 76%; the values of those tested during the second hour ranged from 55% to 77%, the average being 65%; and the third and fourth hours gave results ranging from 48% to 71%, the average being 61%.

From some of these results graphs have been prepared (which will be found in the Appendix), indicative of thermal yield, volume of water gas, coke consumption, &c. (see Figs. 10 to 19).

Set I. contains 6 graphs, lettered A1, A2, A3, A4, A5, and A6, all based on data obtained during a two hours' steaming period with a 12-hour charging cycle. Where necessary each graph has a key, and it is not proposed to give a detailed explanation, as the graphs are self-explanatory. A1 is of the cumulative type; a curve of the thermal yield from complete steam decomposition throughout the period being given as a criterion of that of the actual thermal yield. The curves for coke consumption relate to the latter. A2 is similar in type to A1; here the criterion is the gas volume curve based on 100 per cent. steam decomposition.

Set II. contains 4 graphs, lettered B1, B2, B3, B4, based on data obtained during a three hours' steaming period, with a 13 hours' charging cycle. These are similar to those of Set I.

Set III. contains 3 graphs, lettered C1, C2, and C3, based on data from a six hours' steaming period, with a 16 hours' charging cycle.

From the figures and graphs submitted it will be seen that even during prolonged steaming the efficiency of steam decomposition is good.

The Quality of Coke Produced from Chamber Ovens.

Before deciding on the installation of vertical chamber ovens serious consideration was given to the quality of coke; samples of Durham coke from chamber ovens were obtained and tested. The coke nuts were found to be particularly suitable for domestic boilers, as their fuel capacity was increased owing to the higher density.

Further, the coke was harder and stronger and made less breeze in handling.

Coke made from these chambers has been carefully examined for density and strength; its density is ex-

pressed in weight per cubic yard (dry and graded 2 in. to 2½ in.), and is compared with other cokes as follows:—

Class of Coke.	Type of Carbonizing Plant.	Weight per Cubic Yard.
Durham	Intermittent vertical chambers	804 lbs.
Durham	Horizontals	704 ,,
Durham	Continuous verticals	596 ,,
Yorkshire	Intermittent vertical chambers	722 ,,
Yorkshire	Horizontals	654 ,,
Yorkshire	Continuous verticals	577 ,,

Shatter Test.

The strength of the coke was tested by means of a shatter test, in which a weighed quantity of coke of 2¼ in. size is dropped three times from a height of 6 ft. on to a hard iron or concrete surface and then passed over a 2¼-in. screen again.

The result of the test is expressed by percentage of the original weight of coke that does not pass through the screen, after dropping.

The following gives the result of the above shatter test on intermittent vertical coke compared with other cokes:—

Class of Coke.	Type of Carbonizing Plant.	Shatter Test Per Cent.
Durham	Intermittent vertical chambers	66·5
Durham	Continuous verticals	64·0
Durham	Horizontals	63·0
Yorkshire	Intermittent vertical chambers	64·6
Yorkshire	Continuous verticals	55·0
Yorkshire	Horizontals	61·3

From the above tests it is seen that intermittent Durham coke has the greatest density and strength. It cuts to excellent nuts, having a high carbon content per unit volume, which is a decided advantage in small domestic boilers with limited fuel capacity.

Intermittent coke burns very satisfactorily in open coke grates of modern design.

Tar.

The noteworthy features of the tar made from the intermittents is its low free carbon and naphthalene content.

The quantity of tar made per ton of coal carbonized over a considerable period and varying carbonizing conditions averages 10·2 gallons.

The following is the average result of the distillation of a number of samples:—

—	Per Cent. by Volume.	Per Cent. by Weight.	Specific Gravity.
Up to 200° C.	5·60	4·53	0·917
200°–230° C.	9·41	7·95	0·948
230°–270° C.	10·40	9·06	0·995
270°–300° C.	6·63	5·77	1·002
300°–350° C.	16·70	15·52	1·065
Pitch above 350° C.	..	56·47	..

Dry Tar.

Specific gravity	1·150
Free carbon	1·9 per cent.
Tar acids	4·2 ,,
Naphthalene	2·6 ,,

For preparation of road tar by straight distillation intermittent vertical tar may be considered almost if not quite equal to horizontal tar, and undoubtedly superior to tar from continuous verticals.

Electrostatic Precipitation of Tar.

The detarrers were at work during the seventh and eighth tests only, which were just completed for inclusion in this paper; owing to the fact that these tests were being carried out on minimum output, the detarrers were working at only a 65 per cent. load.

The tar precipitation was very efficient, the average amount of tar *particles* in the gas at the inlet was 4000 grains per 100 c.ft., and at the outlet 2·5 grains, giving a precipitation efficiency of 99·9 per cent.

The temperature of the gas at the detarrer during the above test was 178° Fahr., and it is an interesting fact that the tar precipitated, although liquid at this temperature, became solid when cooled to atmospheric temperature; this is due, of course, to the lighter tar oils passing in the form of vapour on to the condensers, the precipitator thus acting as a fractional condenser.

Special arrangements had to be made to pump the precipitated tar hot to the tar-works, which is situated within 200 yards of the intermittent plant.

The precipitated tar was found to be suitable for making road tar, with the advantage that it will require no distillation.

A comparison with the British Engineering Standards Association's Specification shows that by thinning with creosoté oil a suitable road tar can be readily prepared.

—	B.E.S.A. Tar No 3.	Precipitator Tar.
	Per Cent.	Per Cent.
Oils up to 200° C.	1	*Nil*
,, between 200° and 270° C.	6–12	6·8
,, ,, 270° ,, 300° C.	3–8	4·7

The tar precipitation in the electric detarrer of the carburetted water gas plant previously referred to has proved most satisfactory, giving an efficiency of 99·7 per cent.

COAL HANDLING AND STORING PLANT.

Coal handling, storing, and reclaiming plant had to be provided for the new carbonizing plant, and was an important part in the general layout.

The following is a description of the coal handling plant and the storage plant with the drag line scraper which may still be considered somewhat novel.

Figs. Nos. 6 and 7 show in elevation and plan the storage ground, drag line scraper with tail car, the retaining wall, concrete hopper, and the plant referred to.

The plant installed comprises:—

" Marshall " wagon tippler.
Skip hoist.
Coal breakers and screens.
Band coal elevator and shuttle distributor.
Drag line scraper.

The coal flow diagram, Fig. 8, indicates the travel of the coal; at all points coal is handled in bulk, and the smallest quantity dealt with in one operation is 2 tons, which should result in low maintenance costs.

" Marshall " Wagon Tippler.

This is of the side-tipping discharge type; the wagon is automatically held in position on the rails as the tipping operation proceeds; one side of the wagon comes into contact with, and rests on, a bolster comprising eight pads, then the top of the wagon meets an upper bolster, which is attached to rolling arms; continuing the operation, wagon, rail frame, and lifting arms are rolled along a short path in which teeth on the rolling arms engage until the point of maximum tip is reached.

The capacity of the tippler is 200 tons an hour with ordinary coal trucks, the tipping and return cycle taking 1 min. 40 secs.

The Skip Hoist.

This consists of two balanced skips each having a capacity of 100 c.ft. = 2½ tons of coal, which run on two parallel sets of rails vertically up the skip tower; as each skip descends into the pit it engages a counterbalanced skip bucket loader, which shuts off the coal as the loaded skip rises; the skip hoist is thus entirely automatic.

The speed of travel of the skip is 300 ft. per minute, automatically slowing down to half speed at the top and bottom; for charging and discharging a special auto-retarding arrangement is embodied in the electrical control panel giving a lag variable up to 15 seconds.

The time taken per cycle is 1 min. 25 sec., a load from each skip being delivered to the overhead delivery

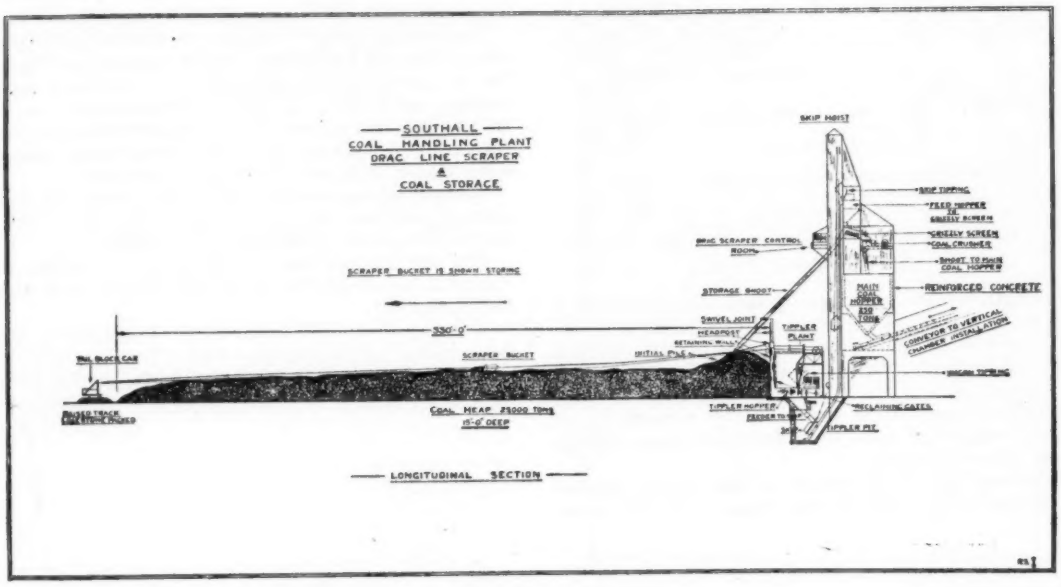

SOUTHALL
COAL HANDLING PLANT
DRAG LINE SCRAPER
&
COAL STORAGE
SKIP HOIST
SKIP TIPPING
FEED HOPPER & GRIZZLY SCREEN
GRIZZLY SCREEN
COAL CRUSHER
CHUTE TO MAIN COAL HOPPER
REINFORCED CONCRETE
DRAG SCRAPER CONTROL ROOM
SCRAPER BUCKET IS SHOWN STORING
STORAGE CHUTE
MAIN COAL HOPPER 850 TONS
CONVEYOR TO VERTICAL CHAMBER INSTALLATION
SWIVEL JOINT
HEADPOST
TIPPLER PLANT
330'-0"
TAIL BLOCK CAR
SCRAPER BUCKET
RETAINING WALL
INITIAL PILE
ENGINE HOUSING
COAL HEAP 29000 TONS 15'-0" DEEP
TIPPLER HOPPER
RECLAIMING GATES
FEEDER TO TIPPLER
TIPPLER PIT
LONGITUDINAL SECTION

FIG. 6.

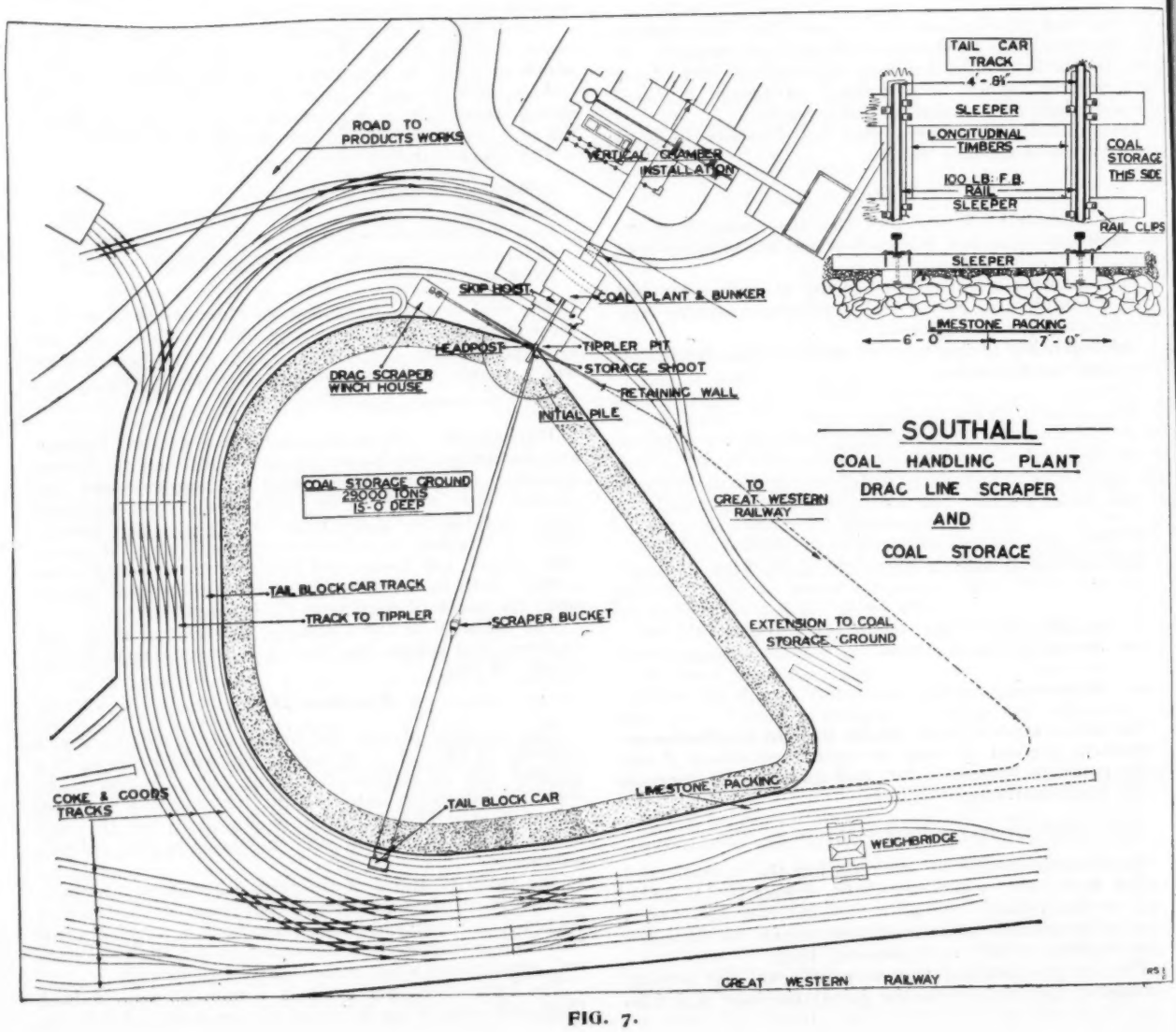

TAIL CAR TRACK
4'-8½"
SLEEPER
LONGITUDINAL TIMBERS
100 LB: F.B. RAIL
SLEEPER
RAIL CLIPS
SLEEPER
LIMESTONE PACKING
6'-0"
7'-0"
COAL STORAGE THIS SIDE
ROAD TO PRODUCTS WORKS
VERTICAL CHAMBER INSTALLATION
SKIP HOIST
COAL PLANT & BUNKER
HEADPOST
TIPPLER PIT
STORAGE SHOOT
RETAINING WALL
INITIAL PILE
DRAG SCRAPER WINCH HOUSE
COAL STORAGE GROUND 29000 TONS 15'-0" DEEP
TO GREAT WESTERN RAILWAY
SOUTHALL
COAL HANDLING PLANT
DRAG LINE SCRAPER
AND
COAL STORAGE
TAIL BLOCK CAR TRACK
TRACK TO TIPPLER
SCRAPER BUCKET
EXTENSION TO COAL STORAGE GROUND
COKE & GOODS TRACKS
TAIL BLOCK CAR
LIMESTONE PACKING
WEIGHBRIDGE
GREAT WESTERN RAILWAY

FIG. 7.

hopper feeding the breakers in this time giving an hourly capacity of 212 tons.

The skip hoist is operated by a winch driven by a 125-H.P. electrical motor.

Screens and Coal Breakers.

The coal is passed over "Robins" grizzly screens, which have a capacity of 200 tons per hour of run-of-mine coal passing up to 2½ in. From the screens the oversize flows to Pennsylvania single-roll breakers (24 in. and 30 in.) with a capacity of 100 tons per hour; the screened and crushed coal falls by gravity into a 250-ton concrete hopper supporting the structure and housing of the breakers, screens, and skip hoist. The screens and breakers are duplicate; their drive is supplied from two 65-H.P. electric motors with belt transmission.

Band Coal Elevator and Shuttle Conveyor.

A chute at the base of the 250-ton concrete hopper feeds a 24-in. band conveyor, inclined at an angle of 19°, having a capacity of 125 tons per hour. Coal is delivered from this band elevator to a shuttle band conveyor of similar capacity, situated over the coal storage bunkers (48 hours capacity), by which it is distributed; the motive power for these two conveyors is supplied respectively by 15-H.P. and 5-H.P. electric motors.

Drag Line Scraper.

This type of coal storing and reclaiming plant was installed owing to its low capital cost, simplicity, and efficiency, and, further, because the site lent itself to its convenient adoption.

The coal storage area available is 85,000 sq. ft., giving a storage at 15 ft. high of 29,000 tons; with the drag scraper, almost the whole of the ground space, irrespective of shape, is utilized to its maximum capacity.

The minimum of labour is required for operating, and the risk of spontaneous combustion was considered to be less owing to the facts that (1) the distribution of the coal in the heap would be more even than when dumping by telpher or crane when lumps fall to the skirt, and the thorough mixing of lumps and fines would reduce the air spaces in the heap; (2) the operation of the scraper travelling backwards and forwards over the heap during distribution would have a consolidating effect and reduce the air interstices to a minimum.

In the event of fire the affected area can be, *and has been*, dug out locally by the scraper without operators being near the burning part and hindered by smoke.

The plant consists of:—

Tail car.
The scraper bucket, 3 cubic yards capacity (about 2 tons).
Head post.
Retaining wall with reclaiming gates.
High and low speed winch drum.

The tail car is a structure carrying the two sheave supports mounted on wheels, and is weighted to 20 tons with concrete, it is prevented from tilting owing to the strain of the cable, by a heavy overhanging channel iron, built out, and attached to the tail car structure throughout its length; this overhanging channel iron takes a bearing on the ground on the inside of the track; the back side of the tail car is also overhung and weighted with concrete.

The tail car runs on rails on a track laid on the outskirts of the storage area, and is clamped to the rails when in the desired position.

The position of the tail car is changed by a hand winch operating wire ropes held to the track by an arrangement of shackles and pulleys.

The method of storing and reclaiming is very simple; for storing, a 2⅜-in. steel cable attached to the front winch drum passes through a sheave on the head post in the reclaiming wall and across the storage space through two sheaves attached to the tail car, then back on to the front bridle of the bucket. A 2-in. steel cable (for pulling back empty bucket) attached to the rear bridle of the bucket passes back through a second sheave on the head post and thence to a second winch drum; the heavy cable can be thus wound on to the first drum through the sheaves on head post and tail car, pulling scraper bucket loaded with coal outwards, simultaneously unwinding light cable from the second drum. The bucket is then pulled back by the drive being changed on to the second winch drum.

For reclaiming, the scraper bucket has to be reversed by changing round the heavy cable running over the tail car with the light cable, an operation which occupies about half-an-hour.

Scraper Bucket.

The drag scraper bucket, which is bottomless, has a capacity of 3 cubic yards (approx. 2 tons), is crescent shaped, and constructed of curved steel plates, the design being such as to give the scraper maximum strength for its weight; the angle and shape of the back plate ensures the loading of the bucket in all conditions of coal with the minimum power consumption, also an easy return of the empty scraper.

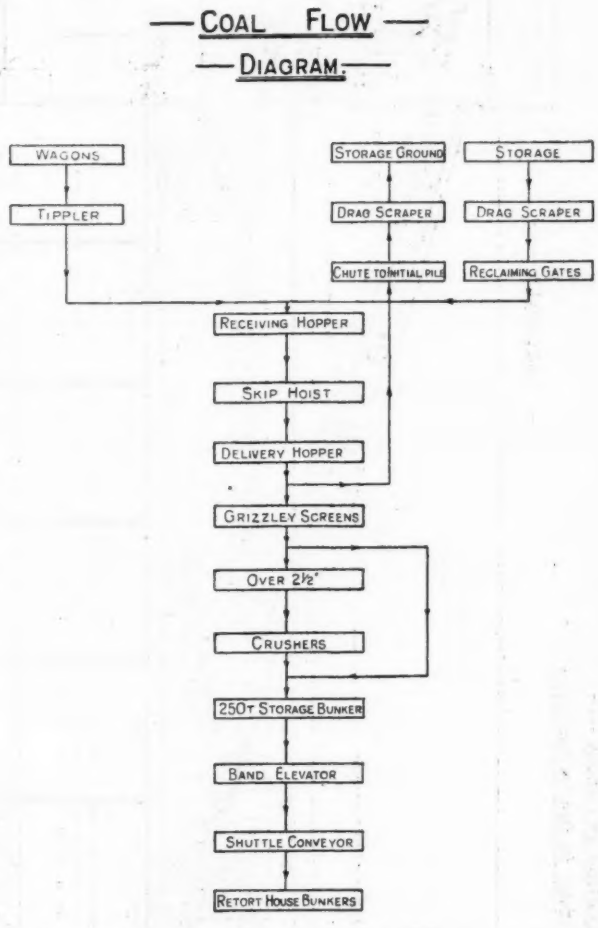


FIG. 8.

The back plate is fitted with a high carbon steel wearing blade, with inside and outside wearing plates at the front ends, on the front edge of which are renewable manganese steel shoes.

Forged steel bridle chains are fitted at the rear and front of the bucket for attachment to the operating cables.

There are two pairs of bushed holes for the front bridle chain; should the bucket show a tendency to overload the attachment of the bridle chains can thus be raised, or *vice versa*.

The two winches are driven by a 125-H.P. electric motor; the front winch drum winding the loaded scraper bucket has a speed of 300 ft. per minute, and the light winch winding the empty bucket a speed of 600 ft. per

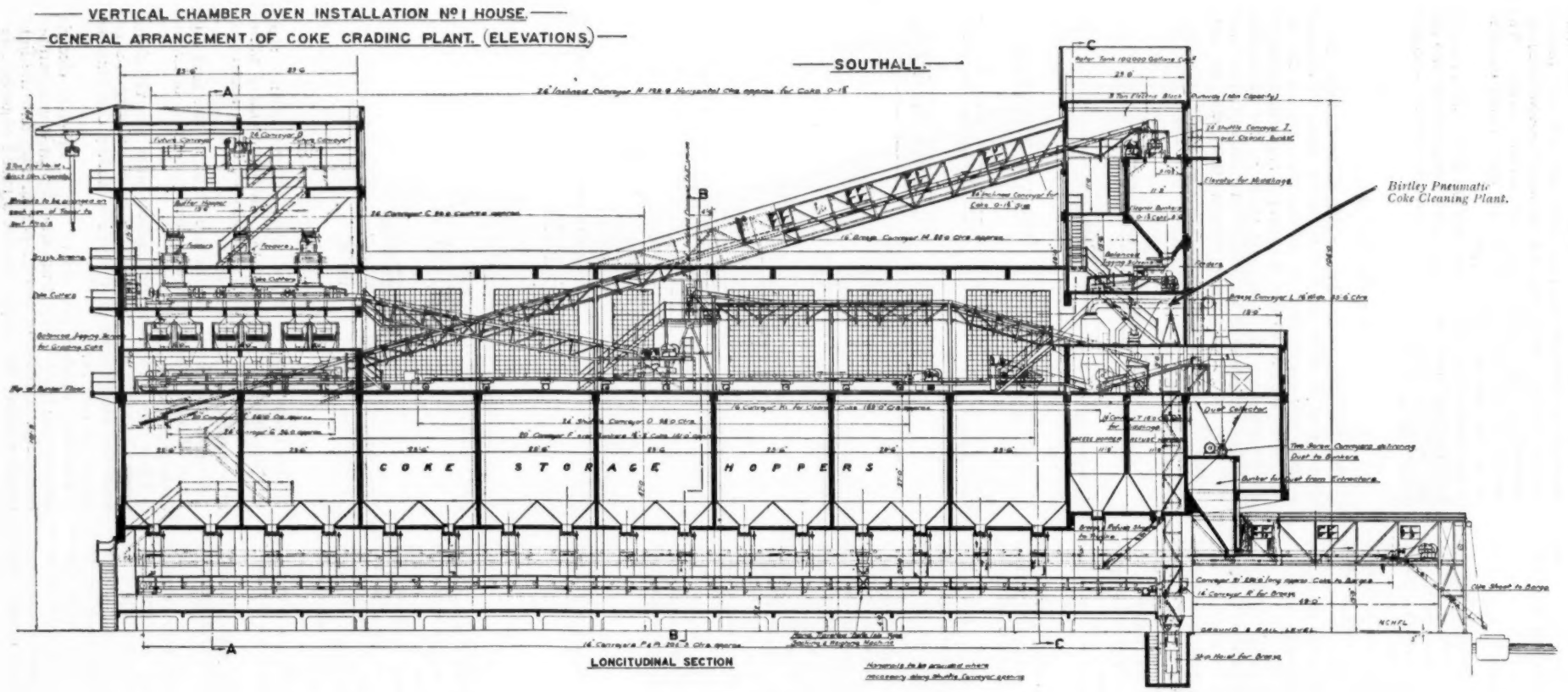

VERTICAL CHAMBER OVEN INSTALLATION No 1 HOUSE
GENERAL ARRANGEMENT OF COKE GRADING PLANT. (ELEVATIONS.)
SOUTHALL.
Birtley Pneumatic Coke Cleaning Plant.
COKE STORAGE HOPPERS
LONGITUDINAL SECTION

FIG. 9.

minute, giving an average bucket speed of 450 ft. per minute.

The control is effected by two reversible motors actuated by switches from the operator's cabin in the skip hoist tower; these motors engage or disengage clutches on the winch drum, at the same time operating the brake mechanism.

An initial heap of coal is made by means of a chute (which can be slewed radially) from the delivery hopper of the skip hoist tower; this heap is then distributed over the area according to the position of the tail car.

When reclaiming, the gates in the reclaiming wall are opened and the coal from store, dragged by the scraper, passes into the tippler hopper feeding the skip hoist.

The quantity of coal handled at 100-ft. radius from the head post is one load in 34 secs., or 210 tons per hour.

With a 300-ft. radius this rate is reduced to 82 tons per hour and intermediate radii *pro rata*.

The normal procedure is to restore and reclaim coal within a fairly short radius to keep level with the capacity of the remainder of the plant, distributing coal when most convenient, thereby levelling out the electrical load.

Cost of storing or reclaiming coal at 150-ft. radius is as follows, with electricity at 0·8d. per unit.

	Cost in Pence Per Ton.
Labour	0·204
Power	0·360
	0·564

Operating Costs.

The operating cost of the coal handling plant and the

transport of the coal from the railway company's rails to the tippler pit are as follows:—

	Pence per Ton of Coal.
Labour—	
Tippler attendant	0·191
Skip hoist, grizzly attendant	0·191
Band conveyor and shuttle attendant	0·130
Labour cost per ton of coal	0·512
Power—Cost of electricity 0·8d. per unit—	
Tippler	0·013
Skip hoist and grizzlies	0·279
Conveyors	0·095
Power cost per ton of coal	0·387
Cost of labour and power	0·899d. per ton of coal
Loco. driver, shunter, weighbridge attendant, and checker conveying coal to tippler	0·600d. per ton of coal

COKE HANDLING INSTALLATION.

In connection with the intermittent verticals, a very complete coke grading, cutting, and dry cleaning plant is in course of construction, and is briefly described. In Fig. 9 the plant is shown in elevation.

This coke handling plant is designed to deal with coke not only from the intermittent installation, but also coke from any other carbonizing unit existing or future, and will be the one central coke handling plant of the works.

Structure.

Of reinforced concrete throughout. Principal dimensions: Length 215 ft.; width, 50 ft. Heights: Ground to top of hoppers, 47 ft.; conveyor housing, 75 ft.; tower at screening and cutting end, 105 ft.; and tower at cleaning end, 118 ft.

Hoppers lined with 2-in. blue brick.

Total capacity, 2000 tons.

Water tank, 100,000 gallons capacity, forms top of cleaning tower.

Plant.

Provision has been made for the screening and cutting plant in triplicate, but for the present one unit only will be installed. Belt conveyors, widths 14 in. to 36 in., 17 conveyors and 3 feeders, total length 1400 ft. When the installation is fully developed a further 700 ft. will be added, including two loading-out conveyors to barges.

Grizzly scalping and gyrex primary screens, each of 30 tons capacity per hour, are provided.

The Pilot single roll coke cutter of 30 tons per hour is to be installed owing to our experience as to its efficiency and low initial and maintenance cost.

All drives are electrical (220 volts D.C.), comprising 21 motors, 3 H.P. to 52 H.P., and 14 single reduction gears.

Dry Cleaning.

The Birtley pneumatic dry cleaning plant, comprising standard "vee"-type separator, dust collector of combined cyclone and bag filter pattern, necessary fans, and middlings conveyor and elevator, is to be installed, and provision made for duplication.

A gyrex secondary screen grading 0 in. to $\frac{5}{8}$ in. and $\frac{5}{8}$ in. to $1\frac{1}{4}$ in. is placed above the separator, and controls for regulation of air speed and coke feed are fitted.

The capacity is 20 tons per hour.

FLOW OF MATERIALS.

Above Hoppers.

From retort house to buffer hopper in screening tower, thence to feeder belt with magnetized head pulley and grizzly. Two-way valve provided so that coke over 2 in. may go either direct to hoppers or to cutter. Coke under 2 in. passes to primary screen previously uniting with coke from cutter. The primary screen grades 0 in. to $1\frac{1}{4}$ in. and $1\frac{1}{4}$ in. to 2 in., the smaller sizes going to cleaning plant and the larger to hoppers. Breeze from cleaning plant can be sent either to hoppers or retort house.

Below Hoppers.

Ample provision is made for loading either to railway wagons or by automatic weighers and sacking shoots to lorries.

Generous access to the coke plant is to be provided by a 40-ft. road on both sides of the hoppers.

Breeze made is taken by two conveyors to a pit feeding a Beaumont skip hoist discharging into bunkers.

CONTROL.

The control gear is situated in a room in the cleaning tower. A complete interlocking and sequence starting and stopping system, emergency stopping devices, and bell signalling and telephone system is provided.

The experience with the intermittent chambers and coal handling plant which have been in operation for six months has proved them to be among the most economical and efficient installed by my Company, and I have no doubt that when the coke plant is finished it will also prove to be equally economical and efficient in the production of clean and well-graded coke most suitable for our customers.

In conclusion, I wish to express my thanks to my Directors and the Chief Engineer for their permission to present this paper, and for the facilities they have allowed to obtain the data.

I also wish to express my appreciation to the Engineering and Chemical Staff at Southall for the assistance they have rendered in its preparation.

APPENDIX.

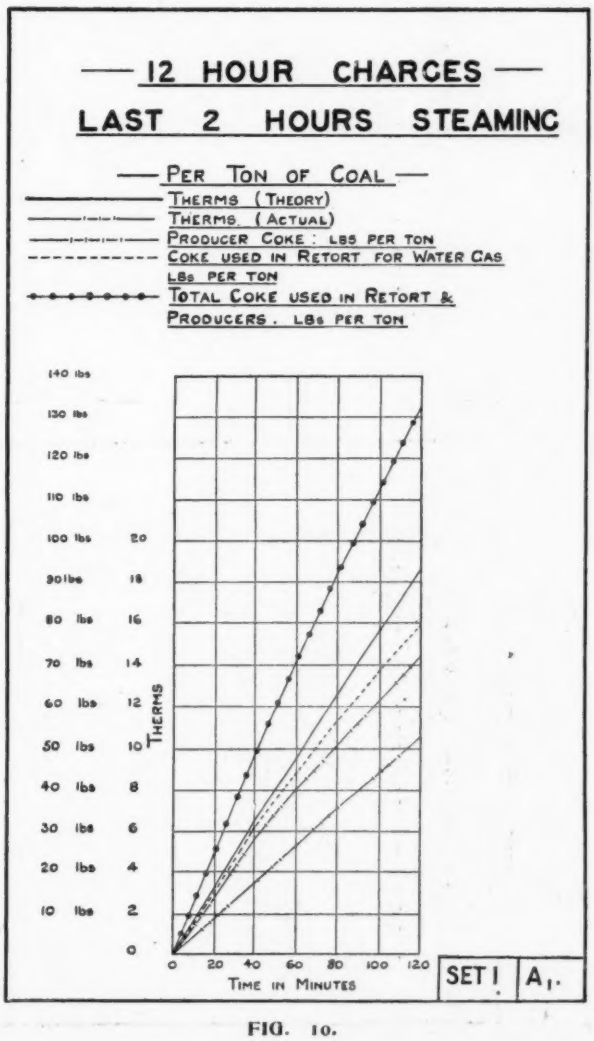


FIG. 10.

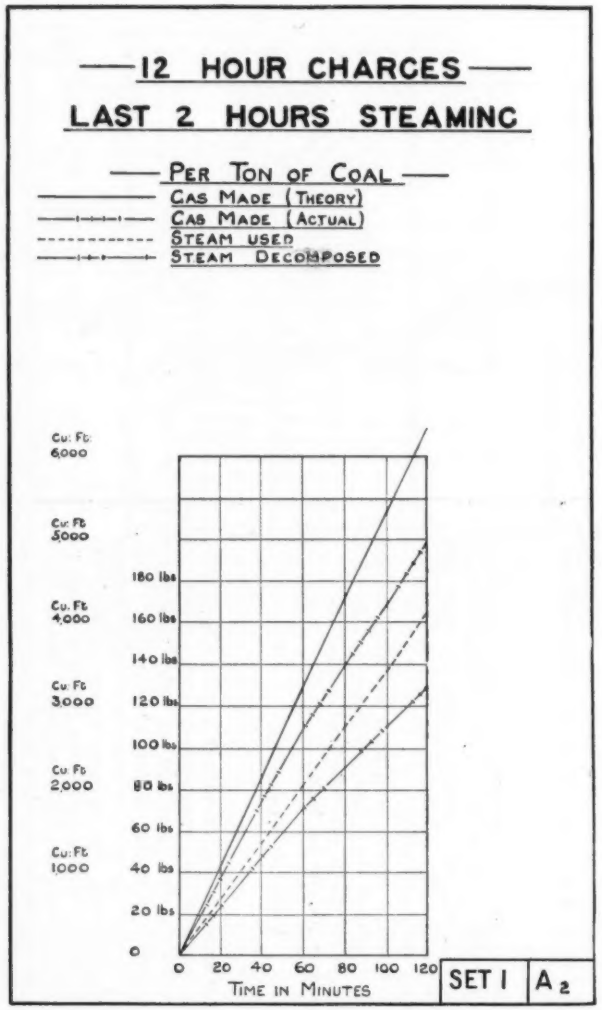


FIG. 11.

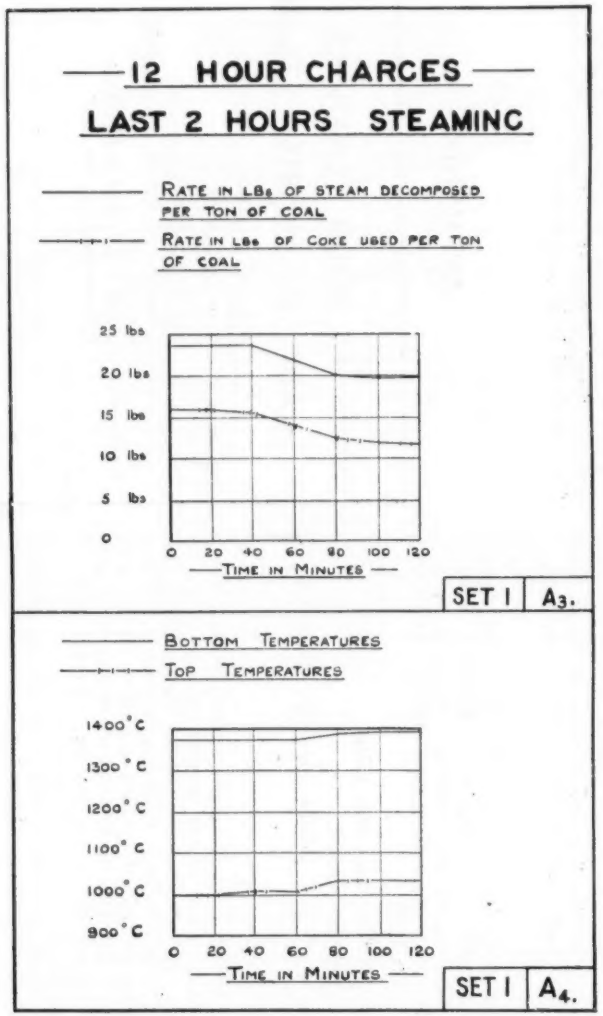


FIG. 12.

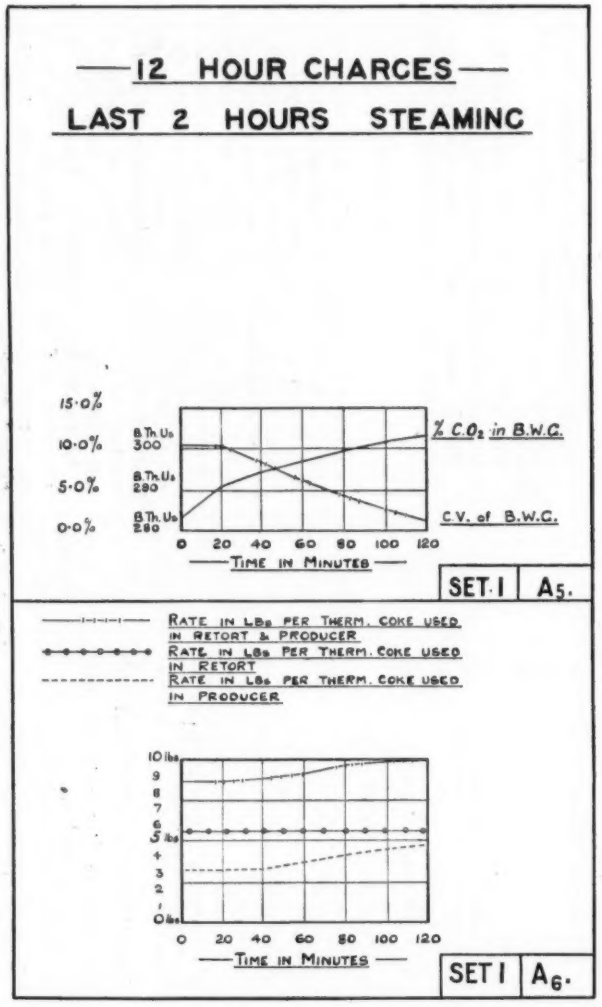


FIG. 13.

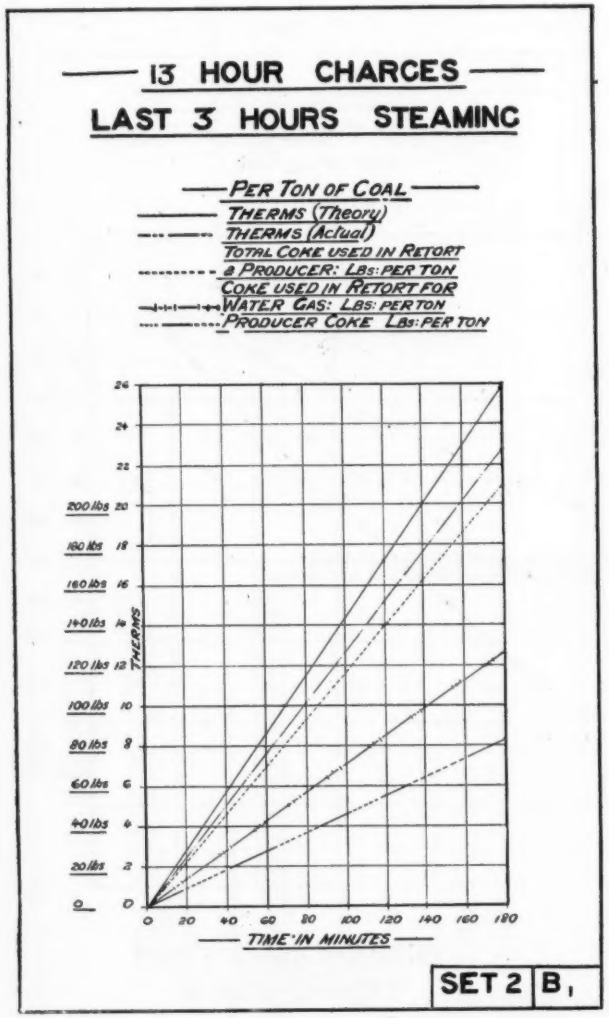

13 HOUR CHARGES
LAST 3 HOURS STEAMING
PER TON OF COAL
THERMS (Theory)
THERMS (Actual)
TOTAL COKE USED IN RETORT & PRODUCER: LBS: PER TON
COKE USED IN RETORT FOR WATER GAS: LBS: PER TON
PRODUCER COKE LBS: PER TON
THERMS
TIME IN MINUTES
SET 2 B1

FIG. 14.

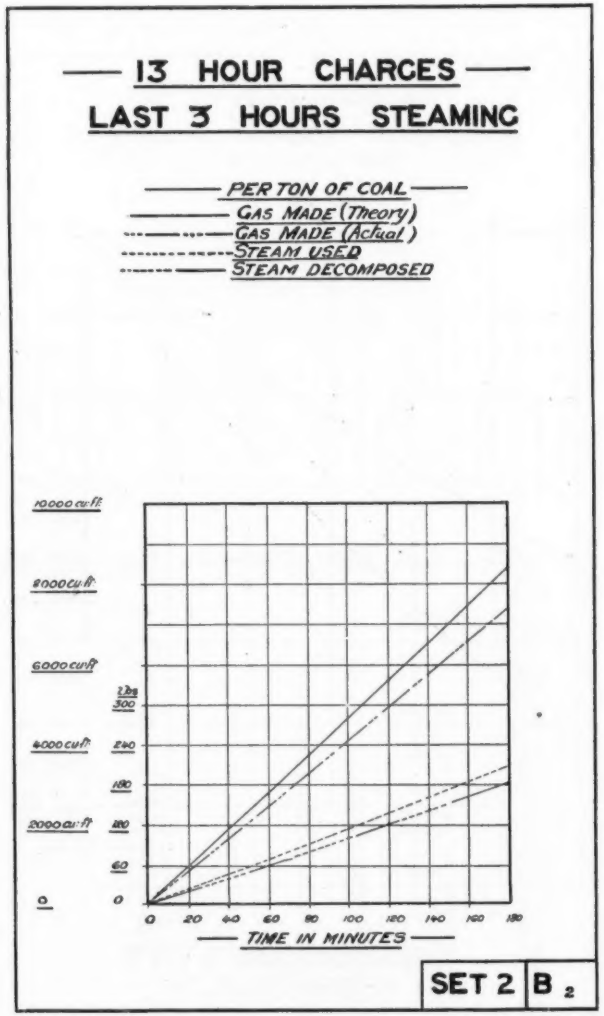


FIG. 15.

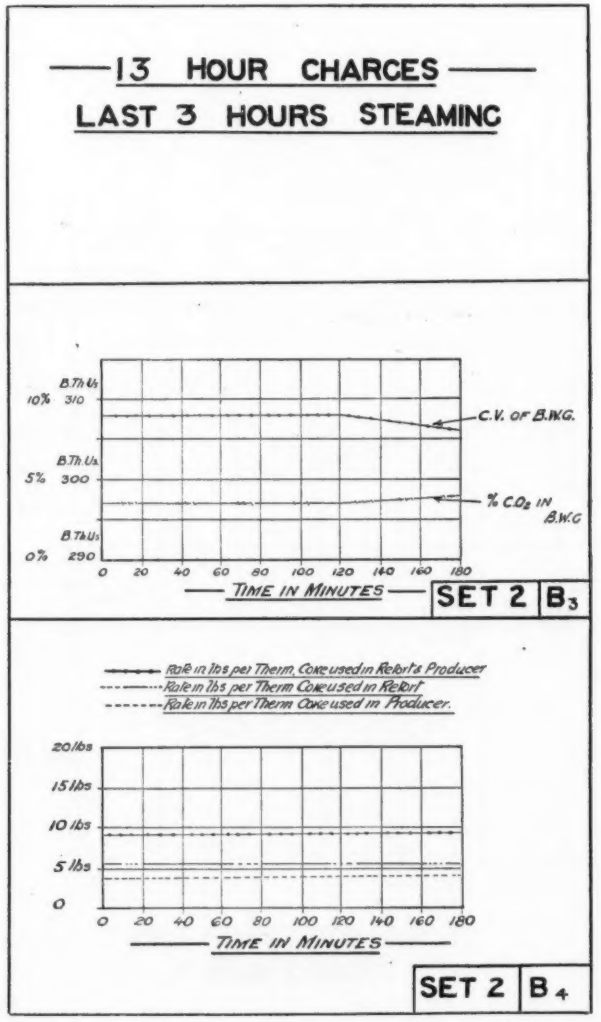

13 HOUR CHARGES
LAST 3 HOURS STEAMING
C.V. OF B.W.G.
% CO2 IN B.W.G
TIME IN MINUTES
SET 2 B3
Rate in lbs. per Therm. Coke used in Retort & Producer
Rate in lbs. per Therm Coke used in Retort
Rate in lbs. per Therm Coke used in Producer.
TIME IN MINUTES
SET 2 B4

FIG. 16.

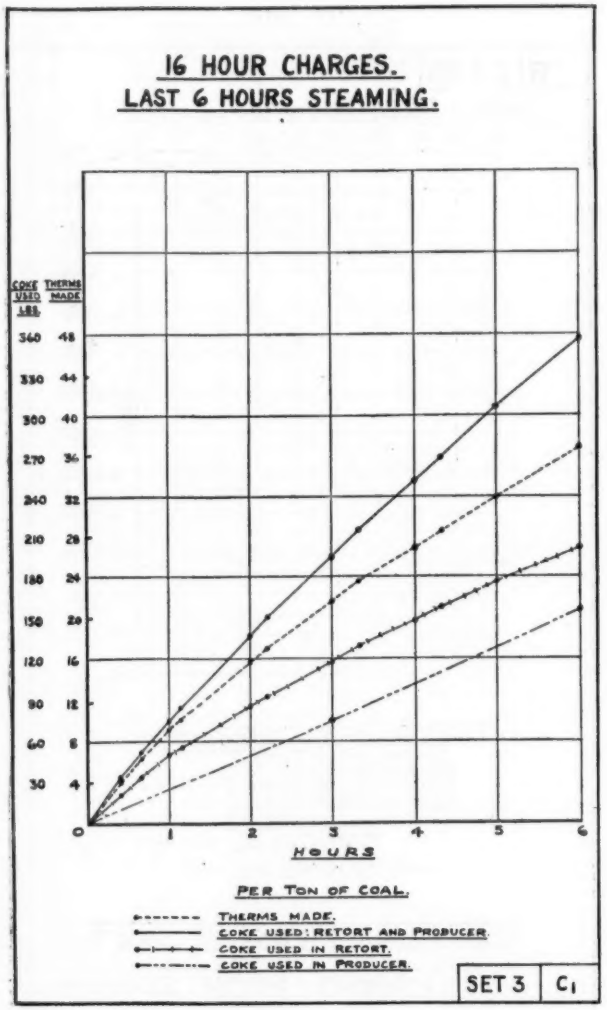


FIG. 17.

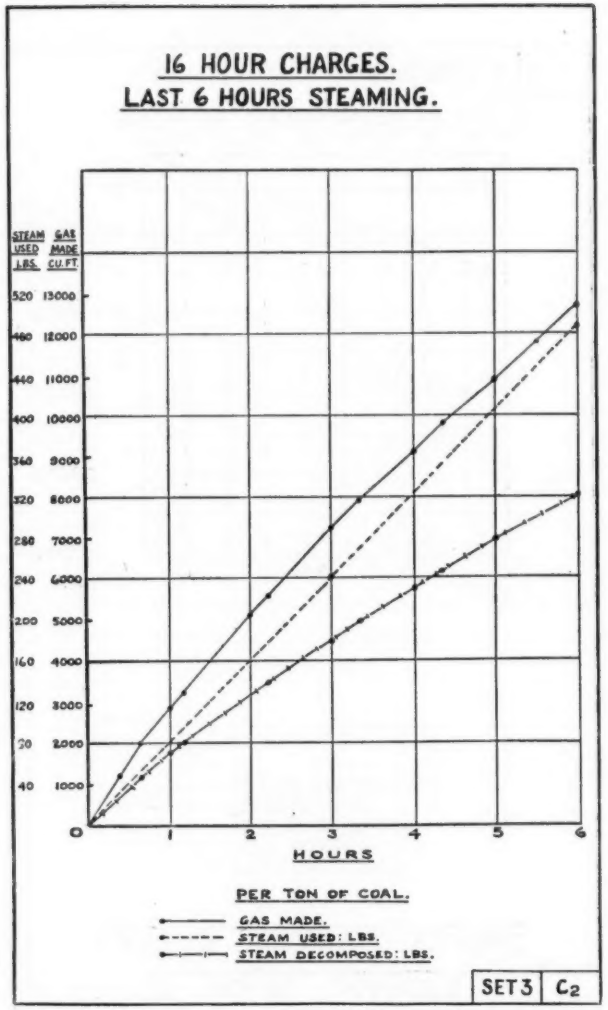


FIG. 18.

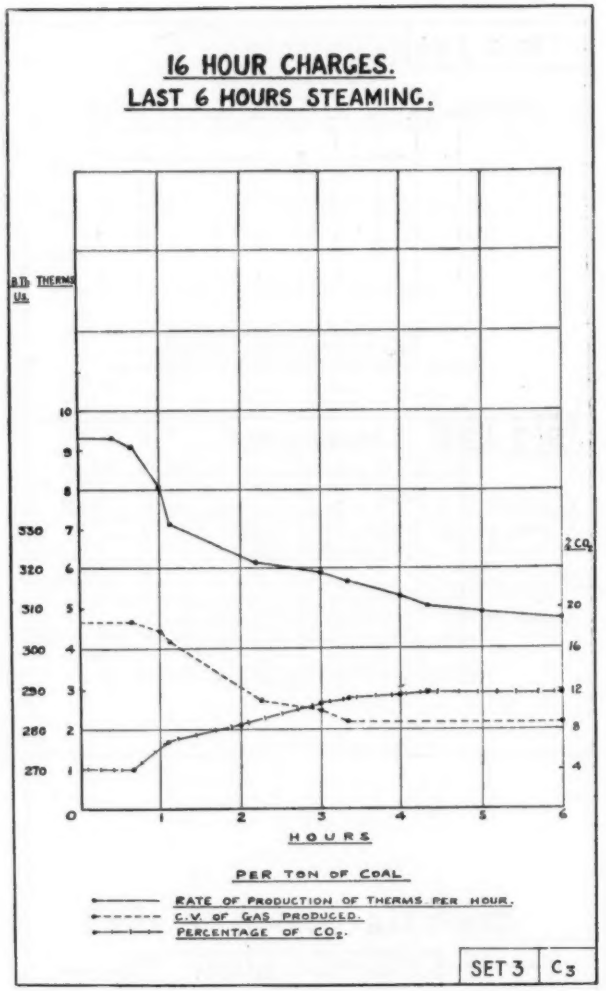


FIG. 19.

DISCUSSION.

The PRESIDENT: We have listened to a very comprehensive paper by Mr. Thorman. It is a paper which I think will well repay a good deal of study. There are one or two questions I should like to ask the author. One is, What is the water content in his coke after quenching? I was also very much struck with the very low labour costs which have been obtained on this rather elaborate plant. I should like to know further why the author decided on separate producers and whether he gave any consideration to the question of whether mechanical separate producers with some apparatus for cleaning the furnace gases might have been adopted. I should also like to have some particulars of the water-cooled tie rods, because I think this is a particularly interesting feature of the installation. Also the fitting of a secondary gas offtake at the bottom appeals to me as very interesting, and I should like it if the author could give us an analysis of the two streams of gas, because it would be extremely interesting to know the difference in the quality of the gas from the top and the bottom offtake.

Mr. H. C. SMITH (Tottenham and District Gas Company): I have been particularly interested in reading the paper which Mr. Thorman has presented—in the first place because anything which Mr. Thorman has to say dealing with the carbonization of coal will always command the interest and attention of members of this Institution; and in the second place because I was privileged to accompany Mr. Thorman on the visit to Germany to which he refers, when a number of intermittent vertical installations of various designs were inspected. On that visit I was very much impressed with this type of carbonizing plant and with the simplicity of its design and operation. It is a plant for which there is practically an unlimited choice of coals. It has great flexibility as to both output and quality of gas, ranging from straight coal gas to blue water gas. The labour required on the plant is light and unskilled. There is no rodding or pipe jumping. The quality of the coke produced is excellent, as is shown by the tests given by Mr. Thorman. Every oven receives a full charge of coal which can be weighed on an automatic weigher—the charge does not depend on the skill of a machine man as in the case of horizontal retorts. There is no free space between the retort walls and the charge, and the formation of naphthalene is low. Coke as it is discharged can be handled in bulk, and it is possible to employ methods of removal which prevent the breaking up of the coke.

Provided the ovens can be retained at work until it is necessary to let them down for repairs, their life should be quite as long as—if not longer than—that of either horizontal or continuous vertical retorts. There is no pusher to damage the ovens and there are no sticking charges as one sometimes gets in continuous vertical retorts, causing local heating. The German engineers with whom we discussed these ovens confidently anticipated a life of from 3000 to 4000 days, and it was stated that there were in fact a number of Dessau retort installations—of which the oven is a descendant—which had given satisfactory results over this period. It should be borne in mind when considering the life of these ovens that the quality of German refractory material is excellent and that it is the practice to carry out carbonization at lower temperatures in Germany than in this country. The opinion generally expressed was that 1350° C. was as high as they would care to go with the 85 p.ct. silica material of which the ovens were constructed.

MINOR AXIS OF THE CHAMBERS.

Mr. Thorman gives the major axis length of the chambers at Southall as being 10 ft. at the bottom, having a uniform taper from bottom to top on the minor axis, but I cannot see that he gives anywhere the dimension across the minor axis. If it is given and I have missed it, I apologize. This would seem to be a very important dimension. If the width across the minor axis is too small, it is impossible for a man to get inside to carry out minor repairs. If, on the other hand, this dimension is too great, the rate of heat transmission will be slowed up and the percentage of fuel increased out of all proportion. I shall be interested to know what width Mr. Thorman finally decided on. Undoubtedly it is most important to brace the ovens very strongly, and the system of bracing which is described in the paper is very interesting and appears to be effective.

One of the most interesting parts of the paper to me is the table given of results under varying conditions. The flexibility disclosed by these results is most important, as the table shows that it would be possible in many cases to keep ovens working throughout the whole of the year by lowering temperatures, and to reduce the make as may be required during the summer months while still retaining the required calorific value. It is interesting to see that when the make is reduced in this way the percentage of fuel is also reduced. This flexibility is most important with ovens such as those described, as undoubtedly the life of the ovens will be very much reduced if it is necessary to shut them down on account of the gas-making requirements at periods other than when repairs are required.

Mr. Thorman and the makers of the plant are to be heartily congratulated on the excellent results obtained on the 28-day official guarantee test as reported in the paper. To obtain 79·71 therms per ton of gas having a calorific value of 510·4 B.Th.U. per c.ft., from coal having a total moisture and ash content of 10·4 p.ct., while using as producer fuel only 14·15 lbs. of dry coke for every 100 lbs. of coal carbonized, is no mean achievement. Our thanks are due to Mr. Thorman for the very valuable information which he has given us in his paper.

The PRESIDENT: I am sorry the time allowed for this meeting has now expired, but the Council will be very glad if anyone who would have spoken had there been time, will kindly submit, in triplicate, their remarks to the Secretary, who will have them published together with the remainder of the Transactions. The author will also reply in that way.

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Problems of Modern Gas Distribution

By Dr. H. SCHÜTTE (Bremen),

Immediate Past-President, German Association of Gas and Water Engineers

The reports, which have been submitted by representatives of the different countries to the Second World Power Conference, indicate that the gas industry is everywhere in a state of active and rapid development. The different kinds of gas, such as coal gas, natural gas, carburetted water gas, oil gas, and coke oven gas, have an ever-increasing consumption and a wider application in all those countries, in which the conditions for their production are favourable. A feature of this development is the considerable extension of long distance gas supplies which, in America alone, employ mains of more than 88,000 k.m. (approx. 55,000 miles) in length, for the widely used natural gas. In England, too, and perhaps even more so in Germany, long distance mains for gas produced either in coke ovens or in gas-works, have increased considerably in extent. The times when gas undertakings confined themselves to the supply of a small district, have passed; to-day, long distance transmission lines extend from gas-works and coke ovens far into the country, and cover considerable areas. In Germany this type of gas distribution has been furthered by the necessity of producing gas at the lowest cost, as a result of which many small undertakings have shut down their works, in order to take their gas in bulk from larger works, or to combine for the purpose of centralizing production. Statistical records show that 690 German gas undertakings own mains of a total length of over 50,000 k.m. (approx. 31,200 miles). Among these undertakings, 104 possess 3,630 k.m. (approx. 2,190 miles) of high pressure distribution mains, apart from 25,300 k.m. (approx. 15,700 miles) of low pressure mains. To these figures must be added the long distance supply lines of the Ruhrgas Company, which are about 1,800 k.m. (approx. 1,120 miles) long, so that the mains used for long distance gas supply in Germany have reached a total length of about 5,500 k.m. (approx. 3,320 miles).

Modern Requirements of Gas Distribution.

In the endeavour to extend the gas supply to other districts, the gas industry has made considerable efforts in order to find new uses for gas, and to meet, in particular, the demand for every form of heat by domestic and industrial consumers. The reports presented to the World Power Conference show that the efforts made in the different countries have attained a considerable measure of success.

With the increasing use of gas for heating purposes, new problems have arisen, the solution of which are engaging the attention of experts in all countries. A satisfactory gas supply for heating purposes can only be guaranteed, when the calorific value, the specific gravity, and the pressure of the gas, is kept constant on the inlet to the gas appliances. The requirements in regard to the calorific value and specific gravity are met without trouble by the gas industry. In many cases, however, difficulties are experienced in regard to the maintenance of a constant gas pressure. The development of the distribution system and pressure regulation was put into the background, whilst the gas industry was engaged in the improvement of gas production, and, consequently, this important branch received too little attention until recently.

As long as gas was used for domestic purposes, a pressure of 50 to 60 m.m. (approx. 2 to 2½ in.) w.g. in the distribution system was adequate. It seemed almost immaterial, if on account of the fluctuating pressure, the gas burner consumed sometimes more and sometimes less at different velocities. The industrial use of gas imposed new demands in regard to pressure, because a perfect article cannot be produced unless the heating process is under complete control. The ever-increasing industrial consumption requires a more and more uniform pressure, which must remain constant, irrespective of the gas consumption. In many cases, the existing low pressure mains are unable to meet the increasing consumption. Their replacement is costly and often impossible, owing to the difficulties experienced in accommodating larger or additional mains in the sub-soil of the present thoroughfares. For this reason, some gas undertakings have raised the district pressure from 70 to 100 m.m. (approx. 3 in. to 4 in.) w.g., whereby a considerable increase in the capacity of the mains has been achieved. An increased district pressure has also advantages in other respects. The performance of gas appliances is usually improved, as according to general observations, variations of the gas pressure in their effect on gas burners become less pronounced, the higher the gas pressure.

Systems for the Control of Distribution Pressures.

When the district pressure is controlled from a central point, it is essential that the mains throughout the district are of sufficient capacity to ensure an adequate pressure everywhere, even at the time of maximum gas consumption. These conditions, however, are unattainable in many towns, and for some years past many large cities have adopted the principle of de-centralized pressure control by employing separate feeder mains, which supply different parts of the low pressure district mains through district governors. This method of pressure control ensures the maintenance of a more uniform pressure throughout the district than a central control, and, at the same time, increases the capacity of the mains appreciably. Experience has shown that, when a low pressure main is supplied from two ends, instead of one, the capacity is increased four times. It is raised eight times, when a third point of supply is placed in the centre. In each case the loss of pressure in the mains would remain the same. The municipal gas undertaking of Vienna has adopted this system of de-centralized pressure control and has laid 85 k.m. (approx. 53 miles) of high pressure mains, which supply, through 38 district governors, the low pressure mains, extending to a total length of 1,560 k.m. (approx. 970 miles). By this means a constant district pressure is maintained.

Notwithstanding a uniform pressure in the district mains, pressure fluctuations on the inlet to the gas appliances still continue owing to the varying loss of pressure in gas services and pipes. Because of this, many gas experts consider that the ideal method of de-centralized pressure control consists in the fitting of a separate governor to every gas appliance, whereby a constant pressure is maintained at the point of consumption. This ideal, however, is unattainable on financial grounds, until an inexpensive and yet satisfactory governor is procurable. For this reason a compromise has been made in several cases by installing a separate pressure governor, so-called " domestic " governor, on the inlet of every consumer's meter. The system obviates the necessity for new feeder mains, and permits greater differences of pressure on the district, which are eliminated by the consumer's governor. If the pressure in the district mains is maintained between 100 and 150 m.m. (approx. 4 in. and 6 in.) w.g., it is possible to maintain everywhere the required pressure of 60 to 80 m.m. (approx. 2½ in. to 3 in.) w.g. on the inlet to the consumer's appliances. This method of pressure control has been adopted by the municipal gas undertaking in Berlin. The gas pressure is kept at 60 m.m. (approx. 2½ in.) w.g. only in the old parts of the city; it has been raised to 120 m.m. (approx. 4¾ in.) in the other parts of the district, where 500,000 domestic governors have been installed on the inlet to the consumers' meters.

Objections are sometimes raised against this system

of de-centralized pressure control, on account of the high capital cost entailed by the installation of the governors and the uncertainty of the cost of maintenance. An alternative scheme, therefore, has been proposed as a more economic method.

In order to supply gas at the required pressure from a low pressure distribution system to all consumers, the gas pressure in the mains is kept between 300 and 500 m.m. (approx. 12 in. and 20 in.) w.g. by feeding them either directly from the works through boosters, maintaining a pressure of 500 m.m. (approx. 20 in.) w.g., or from high pressure mains. A district pressure of 300 to 500 m.m. (approx. 12 in. to 20 in.) is entirely adequate for the majority of industrial consumers and certainly in all cases of domestic consumption and heating installations. Large and small industrial consumers, who require large quantities of gas at higher pressure should be supplied, as far as possible, from high pressure mains, in which, according to requirements, a pressure of up to 5000 m.m. (approx. 200 in.) w.g. is maintained. The installation of separate compressors on the premises of individual industrial consumers is thereby obviated. In all cases where a pressure between 60 and 100 m.m. (approx. 2½ in. and 4 in.) w.g. is needed, as, *e.g.*, in dwelling-houses, a governor is placed in the house service immediately after the main gas cock. This governor is so adjusted that all tenants in the house receive gas at an adequate and constant pressure. In exceptional cases, as, for instance, when the house service is too small, a service governor is not installed, so that a pressure of 300 to 500 m.m. (approx. 12 in. to 20 in.) w.g. is maintained up to the consumer's meter, on the inlet of which a domestic governor is fitted.

The installation of service governors reduces considerably the number of separate governors, and at the same time permits three ranges of pressure to be maintained in the distribution system—namely, (1) a high pressure range of about 5000 m.m. (approx. 200 in.) w.g.; (2) a medium pressure range in the district mains, carrying 300 to 500 m.m. (approx. 12 in to 20 in.) w.g.; and (3) a low pressure range of 60 to 150 m.m. (approx. 2½ in. to 6 in.) w.g. in the house services. By a suitable adjustment of the service governor, any desired pressure within a certain range can be maintained in the inside services.

When new districts are opened up through distant gas supplies it is advisable to adopt the " three pressure range " system, described above, which permits the use of smaller mains, and thus reduces the capital cost. Old district mains cannot be used immediately for this method of pressure control; the change from a low pressure to a high pressure should be gradual and must be carried out systematically. Also, special attention should be given to the design of governors, in particular to the seating of the valves, for a governor should not only function perfectly, but in the interest of safety should shut off the gas completely, when the consumption ceases, and thus prevent the high inlet pressure from reaching the pipes on the outlet of the meter.

The adoption of higher distribution pressures and the de-centralized control opens new possibilities for the further development of the gas industry, and provides opportunities for an increase in gas consumption, which should be the aim of gas engineers in all countries.

Developments in Meter Design.

The improvements in gas distribution brought about by the increase in gas pressure and the de-centralized pressure control are not sufficient to ensure a satisfactory gas supply without similar improvements in gas meters.

Only high capacity gas meters should be installed, which give a low differential pressure and possess a calibration curve practically unaffected by the rate of gas consumption. For many years insufficient attention has been paid to the design and the importance of the gas meter. It was regarded as an almost perfect piece of apparatus not in need of any improvement. It was only when the Government in Germany contemplated legislation in regard to the re-proving of meters at intervals of five years that the gas industry in Germany concerned itself more closely with gas meters.

An examination of consumers' meters *in situ* produced the surprising result that in regard to accuracy of registration the " dry " meter was superior to the " wet " meter, which suffers from changes in the water level, and often fails to remain in a perfectly horizontal position. A further comparison between the two types showed that, at the same rate of consumption, the differential pressure across the meter is less in the " dry " meters than in the " wet " meters.

These discoveries caused the engineer and manager of one of the largest German gas undertakings to carry out experiments of a fundamental nature in regard to the capacity and design of gas meters, after a thorough study had been made of the principle of designs with a view to revealing their faults. As a result of this important work, which was carried out over a number of years, the design of gas meters showed a substantial improvement, which principally concern the following points:—

(1) The hourly capacity of the " dry " meter of 5 litres (approx. 0·176 c.ft.) capacity per revolution, giving a differential pressure of 10 m.m. (approx. 4-10 tenths) w.g., was raised within a few years from 3 cu.m. to 10 cu.m. (approx. 106 c.ft. to 353 c.ft.), and in one particularly well-designed type to 12 cu.m. (approx. 424 c.ft.) per hour.

(2) The sensitiveness of the gas meter increased from 20 litres (approx. 0·7 c.ft.) per hour to 2 to 3 litres (0·07 c.ft. to 0·1 c.ft.) per hour.

(3) The calibration curve became more and more independent of the rate of gas consumption.

Most meters still show a tendency to register low, when the flow of gas consumption increases; there are several models, however, whose accuracy is almost independent of the rate of gas consumption.

(4) Pressure fluctuations rather decreased than increased.

(5) A long period examination on the test bench, during which 1,500 cu.m. (approx. 53,000 c.ft.) of fresh gas were passed through the meter for each litre of meter content, gave the following results:

(*a*) The capacity of the meter remained constant.

(*b*) In the case of slide valve meters, the calibration curve at the end of the test showed that a maximum error of 1½ per cent. was incurred through the meter being slow. In the case of well designed poppet valve meters, there was practically no change in the calibration curve. At higher rates of gas consumption the negative errors diminished and had even a tendency to become positive.

(*c*) The sensitiveness was practically the same for both a good type of slide valve and poppet valve meter.

The experiments further showed in regard to the design that slide valves, with a wide bearing surface, are unsuitable on account of the low pressure acting on the sliding surfaces. The usual metals employed in the construction of the valves are satisfactory, so that hard metals, such as chromium-nickel-steel, would not seem to be more suitable. Metals of a low degree of hardness and of coarse crystalline structure give rise to the accumulation of dirt, which causes leaks, noise, and low registration.

The statistics collected during the years over which the experiments extended revealed the following interesting facts in regard to the different types of gas meters:—

(1) The mass production principle adopted in meter works, with intermediate examination stages, has produced a considerably better article than the ordinary method of production, to which some manufacturers still adhere.

(2) The defects of the individual models are discovered without difficulty.

Serious defects on slide valves have been reduced to a minimum.

As a result of the closer examination to which gas meters have been subjected certain improvements have been produced on the different types, so that gas undertakings are placed in the position of using, with proper selection, gas meters of a capacity of 5 litres (approx. 0·176 c.ft.) per revolution for hourly consumptions from 8 to 12 cu.m. (approx. 282 to 424 c.ft.), whereby the capital outlay is reduced considerably. In addition, the use of such a

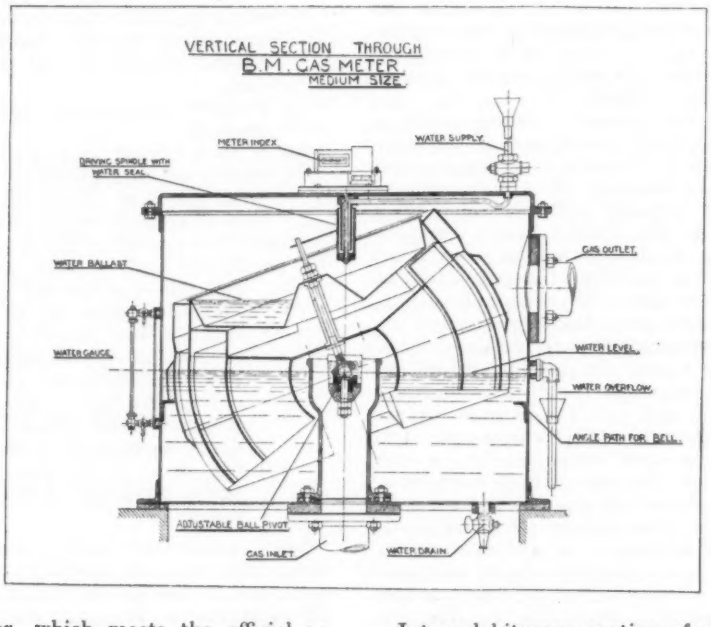
meter obviates the formerly inevitable costs entailed through its replacement by a bigger meter, when larger appliances, such as geysers, &c., are installed.

The improvement in the design of the meters also lowers the cost for repairs and reduces the " unaccounted-for " gas. The annual saving accruing from the different factors has been estimated by a large gas undertaking at 4 R.M. (approx. 4s.) per installed meter. It, therefore, pays gas engineers to devote their special attention to gas meters.

Meters for Large Gas Volumes.

The measurement of large gas volumes as supplied to industry has been the subject of investigations by gas engineers of all countries during the past few years. The ordinary gas meter, working on the Crossley principle, is limited to a maximum size of 6,000 cu.m. (approx. 21,200 c.ft) per hour, as its dimensions would become unwieldy and its price too high. In the absence of another reliable type of displacement meter, the gas industry has employed other methods for the measurement of large gas quantities, such as the rotary meter, the orifice and orifice plate, the Venturi tube, and, latterly, particularly in America, the revolving impeller meter. None of these measuring devices is accurate at varying loads, and must be considered as a makeshift.

The Brandl-Marischka meter was, therefore, welcomed as a displacement meter, which meets the official requirements for testing and stamping. It gives accurate measurements, independent of the load and irrespective of the water level in the meter. It is designed for hourly gas consumption of 100 to 20,000 cu.m. (approx. 3,530 to 706,000 c.ft.), and seems likely to replace the ordinary station meter. The Brandl-Marischka meter consists of a spherical bell, placed centrally in a casing. The bell moves on an angle iron, fixed to the casing, and describes the path of a flat eight in the meter water. It is divided by four partitions into four compartments, which are making oscillating movements, when the bell rotates. The steering mechanism consists of special chambers attached to the bell, which move simultaneously with the measuring chambers, and control the charging and discharging of these chambers. The design of the meter is shown in the accompanying sketch.



A different principle is embodied by a gas meter, designed by Messrs. Ernst Eickhoff, Wuppertal, which also can be tested officially and stamped. Its dimensions are only a tenth of those of the ordinary " wet " meter. It consists of two bells connected with arms to a common shaft, which acts as a gas distributor and rotates at 2,000 revolutions per minute. Unfortunately, details of the construction cannot be given at the moment as final patents have not been granted. Experiments which have been carried out by a member of the German National Physical Laboratory, and also by the Ruhrgas Company, have shown that the error of measurement between zero and maximum gas consumption remains within *plus* and *minus* 1 per cent.

Rust and Dust Deposits in Mains.

The German gas undertakings, which have high pressure gas mains, experience increasing difficulties through the deposition of dust in the mains. This dust, which, according to samples taken from a main worked from 2 to 3 atmospheres (approx. 29·46 to 44·1 lbs. per sq. in.) of pressure, has the following composition: —

2 to 6 per cent. naphthalene.
10 to 20 per cent prussian blue.
1 to 2 per cent. ammonia.
1 to 3 per cent. sand.
66 to 70 per cent. iron oxide.

The material, therefore, consists mainly of rust, produced from the mains, as the result of water condensation from the compressed gas, which is saturated with water vapour at 15° C. The corroding influence of the water is increased through the carbon dioxide and oxygen content of the gas. Without doubt the rust formation has been increased through the debenzolization of the gas during the war period, whereby the protective influence of the heavy hydrocarbons was removed.

Internal bitumen coating of mains, produced by dipping, has not proved a satisfactory protection against rusting. Even if the amount of rusting found in the mains is not serious enough to give rise to anxiety in regard to the life of the mains, the dust itself is a nuisance and gives rise to trouble with the governors on the district. Its removal is, therefore, highly desirable.

In America and England, also, dust formation in gas mains has been observed, and notably by those undertakings which have introduced plants for the dehydration of their gas. The dust has been particularly marked immediately after the installation of dehydration plants, and has been explained by the hypothesis that the rust, which was retained by the moisture deposited from the gas prior to the dehydration, was carried forward by the dry gas after the installation of a drying plant. The difficulties experienced in regard to dust deposits disappeared again after a time, so that the conclusion is justifiable that dry gas prevents the new formation of rust.

Attempts have been made to prevent the dust being carried forward by the gas through the addition of vaporized or atomized oil. Only a limited success has been obtained, as the oil is mostly deposited within close proximity of the works. It has, therefore, been recommended to supply the syphons of high pressure mains with small quantities of oil, so as to retain the dust from the

mains. For the removal of dust from the mains, dust catchers are installed in places where the direction of the gas changes. The dust is collected in these pockets, and can be removed at intervals. For the protection of the governors dust filters have been introduced into the services, which, however, have not been successful. Some of them consist of horse-hair, and have not been effective. Others made of several layers of textile offer too much resistance. As long as the formation of rust and dust in high pressure gas mains exists, high pressure governors should be designed in such a way that no trouble can be caused through dust. According to the practical experience gained by a number of German gas undertakings, high pressure gas governors should satisfy the following points:—

(1) They should be fitted, exclusively, with single seating valves.
(2) The seating should be in a vertical position.
(3) They should close with considerable pressure.

At the same time every attempt should be made to devise effective means for the prevention of rust formation in the mains, as the protective coatings used up to the present have proved to be unsatisfactory. It would be even better if an economic process could be developed for the removal of carbon dioxide, oxygen, and moisture from the gas, each of which play a part in the rusting of the mains.

Dr. SCHUTTE, before outlining his paper, said: Please allow me to say a few words on behalf of my Association in Germany to express our gratification that you have enabled us to attend your meeting this year again. I have been asked to convey to you our heartiest congratulations and the hope that this meeting will be successful, not only for the Gas Industry in England but for the Gas Industry in the whole of the world. It is a very great honour to me to read a paper before your Institution, and especially at this historic meeting which constitutes the first International Gas Conference. I am very glad indeed that I have been allowed to contribute a paper to this conference, and especially in this lovely country of yours, which was the birthplace of the Gas Industry in England, and, indeed, for the whole of the world, and we owe very great thanks to those engineers who have developed the Gas Industry to the point it has reached to-day. I hope the endeavour on the part of the various nations to work together will contribute to the further development of the Gas Industry as a whole.

DISCUSSION.

The PRESIDENT: I am sure we have all been very interested in listening to the résumé of this paper which has been given to us by Dr. Schütte. I think the development in long-distance mains is remarkable. In America alone I understand there are some 55,000 miles of long-distance mains, and in Germany there are no less than 3300 miles. These are not necessarily high-pressure mains. I think, however, for the most part that they are becoming more or less high pressure because of the difficulty of distribution over long distances. It is also remarkable that in Berlin alone there are 500,000 domestic governors. I do not think the type of governor used in Berlin is one which is used extensively in this country, because I believe the governor which they use in Germany requires rather more initial pressure to work it than the types which are commonly in use in this country. Dr. Schütte says that in Germany they have three standards of pressure. They have a high pressure of about 200 in. water gauge; they have a medium pressure of from 12 to 20 in. water gauge; and they have what we call a low pressure of from 2½ to 6 in. water gauge. The latter is the one which we are up against, principally in this country. I am one of those who advocate very strongly the use of either consumers' governors or district governors, because gas lighting depends entirely on equable pressures; and, of course, if we are going to use increased pressures on account of lack of capacity in our mains, there is only one thing to do, and that is to use governors. What Dr. Schütte has said about the developments with consumers' meters in Germany is extremely interesting. They appear to have done a great deal in the improvement of consumers' meters in Germany, and that is a very important subject, because, as we know, unless a meter will register very minute quantities of gas and you have a multitude of meters—hundreds or thousands or tens of thousands—a very small quantity of unregistered gas multiplies up into a very serious quantity in the aggregate. I was also interested in Dr. Schütte's analysis of the rust which is found in pipes, I presume after the gas has been dried.

Dr. SCHUTTE: Yes.

COMPOSITION OF RUST.

The PRESIDENT: Dr. Schütte finds that from 56 to 70 p.ct. of the rust consists of iron oxide; and it is interesting to know that in my own case the iron oxide is 62·36 p.ct. That is, of course, under totally different conditions of distribution and probably some slight difference in the composition of the gas. I think our thanks are due to Dr. Anderson, who has not only been good enough to translate Dr. Schütte's paper into English, but has also materially assisted in making clear Dr. Schütte's meaning this afternoon. At the same time, I only wish I could speak German as well as Dr. Schütte speaks English.

IMPORTANCE OF CONSTANT PRESSURE.

Mr. STEPHEN LACEY: As the President has said, Dr. Schütte has presented us with a very valuable paper, particularly valuable because the familiar problems of gas distribution are seen in a new light and arouse special interest when they are re-stated and discussed by an eminent authority from another country. There can be no possible doubt that distribution costs have an increasingly important bearing on the competitive strength of the gas industry, particularly *vis-à-vis* electricity, and it is necessary that existing practice in gas distribution should be continuously subjected to criticism and amendment. I am very glad that Dr. Schütte has also laid special emphasis on the importance of maintaining a constant pressure on the inlet of gas appliances. That is equally important all the world over, because it must always be the primary object of gas distribution. Everyone recognizes the necessity for keeping the pressure available at the inlet to a gas appliance above a certain minimum, but I do not think that all fully recognize the importance of preventing the pressure available at peak loads from being exceeded at other times. That is a very important point; and at the risk of labouring it I will give an extreme example. Suppose the gas pressure available at the inlet to a gas heating appliance is 4 in. water gauge at peak load, and that at other times the pressure is 9 in. I said this was an extreme example, but I am not at all sure that it is.

However, the burner of the appliance will probably be adjusted to develop its full heating capacity at a time off the peak load. If this is so, the heating capacity of the burner at the time of the peak load will be only two-thirds of the maximum—*i.e.*, it is in the ratio of the square root of the pressure. Where the heating capacity will be proportional to 3 at 9 in., at 4 in. it will be 2, in spite of the fact that the pressure of 4 in. would be more than sufficient to develop the full heating capacity if the burner was suitably adjusted for that pressure. In this country up to the present we have done our best to deal with the problem of keeping pressure variation in low-pressure mains within tolerable limits by installing additional district governors as the demand increases—thus reducing the size of the areas served from one distributing centre—and by laying relatively high-pressure feeder mains to supply the district governors.

In the old-established districts where they have been served with existing mains of fairly ample capacity, this method has, I think, been economical and effective, but I think there is much to be said for the future that in new districts we can achieve our object of ensuring a constant pressure at the inlet of all gas appliances with greater certainty and at a lower cost if we freed ourselves from the necessity of keeping pressure losses in the low-pressure mains within such narrow limits, and resorted to the use of governors on our consumers' premises. This, Dr. Schütte has told us, is the method of pressure control adopted by the municipal gas undertaking in Berlin for their suburban areas. They are using what Dr. Schütte calls domestic governors, which correspond to our service governors. Of course, domestic governors will only serve the purpose, provided the size of the house pipe is adequate. As Dr. Schütte has himself pointed out, if you have a small house pipe the service governor has a very limited use, but in new districts house pipes should certainly be of ample capacity; and therefore a service governor is of very great value, and it is not in that case necessary to resort to governors on the inlet of every gas appliance.

There is another difficulty about resorting to governors on every gas appliance and that is that it does not touch gas lighting. With gas lighting I do not see any real alternative to service governors. The time has certainly come for giving this question of the use of governors on low-pressure supply more serious consideration, because the cost of solving distribution problems without governors continually increases as the standard of what constitutes a satisfactory supply is raised, and the tolerable variation of

pressure at the inlet of appliances is correspondingly reduced.

A Prevalent Misconception.

I should like to say a word or two about a prevalent misconception as to the true function of a governor on consumers' premises. It is remarkable that many people, some of them in the Gas Industry, think of a service or appliance governor as a device primarily intended for preventing waste of gas; and that, no doubt, is why persons outside the Industry make a living by selling governors to our consumers which they invariably call gas economizers, but, as a matter of fact, the chief function of a service or appliance governor is to enable the appliance to develop its full heating capacity at peak loads. This will be clearly seen by considering the example I have already given of pressure varying from 4 in. to 9 in. It is obvious that in such a case the installation of a governor loaded for (say) 3 in. would ensure an entirely satisfactory supply at all times, and leave a margin of nearly 1 in. of pressure in the main, provided the governor has been so designed that the pressure loss through it at the maximum rate of flow is no more than one or two tenths of an inch. In this country, as I say, we have rather fought shy of service and appliance governors, for good and sufficient reasons; but I have no doubt that they will be much more used in the future for industrial appliances. There is one other point in Dr. Schütte's paper which I should like to comment on particularly, and that is the section which deals with consumers' meters. It appears from the information given in the paper that the developments in meter design that have led in this country to the so-called "high-capacity" meter, have been carried very much farther in Germany. I note that one meter referred to has an hourly capacity of 424 c.ft. with a capacity per revolution of only 0·176 c.ft. That is to say, the revolutions per minute of that meter at full capacity are 40 as compared with about 8 for the corresponding English meter. Am I right in that?

Dr. Schutte: Yes.

Mr. Lacey: Moreover, we are told that this remarkably high capacity in relation to the size of the measuring chambers is accompanied by accurate registration from 1 c.ft. per hour to the maximum capacity, by a low pressure loss and by good wearing properties; also, that the life of the meter is not reduced by this high speed. I am not myself a meter expert, but I hope that in the course of the discussion somebody who is more expert than I am on the question of meter design will speak on these points. There are several interesting questions raised in the paper that I should like to touch upon, but time is too short; and I will conclude by expressing my personal thanks to Dr. Schütte for a very valuable paper.

Virtues of Wet Meters.

Mr. Ralph E. Gibson (Liverpool): There is one point I should like to draw attention to with regard to the paragraph dealing with meters. Dr. Schütte says "An examination of consumers' meters *in situ* produced the surprising result that in regard to accuracy of registration the 'dry' meter was superior to the 'wet' meter, which suffers from changes in the water level, and often fails to remain in a perfectly horizontal position." We in Liverpool have used wet meters ever since the Company was formed, and we have found them much more reliable than dry meters. I think Dr. Schütte has overlooked the fact that most wet meters to-day are made with a compensating device for maintaining the water level; and I think it is indisputable that the wet meter is a more accurate measuring instrument than the dry meter if the water level is maintained. With regard to the point mentioned by Mr. Lacey, relating to the very high capacity of the dry meter —namely, a capacity per revolution of 0·176 c.ft.—I may say that we tested only last week a high-capacity meter of a very good make, and the utmost we could get out of it at a differential pressure of five-tenths was 124 c.ft. This figure of 424 c.ft. seems to be very remarkable, and I should like to know how it was obtained.

The President: I need hardly say that if there is anyone interested in the manufacture of meters present, any remarks they may care to make will be very welcome.

Effect of Pressure Regulation on the Lighting Load.

Mr. A. M'Ivor Cleland (Belfast): It will be a pity for a paper of this nature not to lead to a lengthy discussion, and I am stepping into the breach to keep the ball rolling, so to speak, for a few moments. I should like to emphasize what has been said regarding the use of service governors. I am becoming more and more convinced that we are losing business on the lighting side through not regulating the supply. Domestic premises, particularly in those districts where pressure-wave controllers are in use for street lighting, are a difficulty, because I know from my own personal experience that consumers have said, in language I will not repeat here, "I will not use gas for lighting because of your darned high pressure at night." When the pressure goes up to 3 or 4 times what it ought to be, and results in the fracture of mantles, you must not be surprised if we lose a certain amount of lighting load.

Steel Mains.

I am not sure whether I am in order in speaking about another aspect of distribution, and that is concerning the use of steel mains. I am not going to introduce here the old controversy between steel and cast iron, but I would like to ask whether any of you have had sufficient experience of the coverings which are as a rule applied to steel mains, to be able to decide whether these coverings are permanent. Personally I have very considerable doubt, although possibly from a somewhat limited experience. The usual wrapping, as you know, is burlap and bitumen. I find that where there is any leak in the steel main round about the joint, the bitumen is dissolved. The wrapping is then in a position to be affected by moisture in the soil. It rots, and the life of the steel main at that point is very much reduced. Furthermore, I came across a most extraordinary instance the other day of a steel pipe wrapped with burlap and bitumen. That main had been laid for 16 years and apparently it developed a small leak. On opening the ground a portion of the wrapping about 18 in. long was found to be completely rotted, and an extremely minute quantity of gas was making its way through a minute defect in the steel. The area affected was not more than could be covered by a threepenny piece. The effect was not visible except under a magnifying glass, but in the 16 years the main had been laid the bitumen had been dissolved. The burlap was then left exposed, and had rotted; and the whole of that length of steel main was freely pitted. It seems to me that therein lies a risk in the use of steel mains. Again, sometimes a steel main is covered entirely in bitumen. In one case where the main was used for conveying oil, it was laid in a wooden trough filled with bitumen to such an extent that nowhere was there less than 1½ in. thickness of bitumen over the steel pipe. In three or four years the pipe developed a leak of oil in that case, and it was found to be punctured, presumably by accident. Twelve months later another leak developed in the same pipe and near the same spot; and after a very careful examination I discovered that what had happened was that the bitumen had been punctured by an over-lying stone, bitumen, as you know, not being solid at all. The punctured bitumen had left the portion of the steel pipe exposed, and the chemical constituents in the moisture in the soil in that particular street had drilled a neat little hole about ⅛ in. diameter in the steel pipe. I doubt, therefore, as to whether bitumen applied in that form to steel is absolutely safe.

Poppet and Slide Valves.

Mr. A. T. Gilbert: I do feel that a word should be said for the efforts which are being made to provide meters of a more serviceable character. I think the lack of debate on this subject is indicative of the attitude of the Gas Industry to-day with regard to meters in general. There seems to be an appalling apathy on the part of the Industry towards what is really a matter of considerable importance to your revenue. Dr. Schütte's remarks about the delivery of the meters of high capacity which are being made in Germany interest me; and I should like to ask whether this high return of 424 c.ft. for an inch drop in pressure refers to the meters with poppet valves or slide valves.

Dr. Schutte: They are mostly slide valves.

Mr. Gilbert: I am rather surprised at that for the simple reason that we should expect to get better results from the poppet valve arrangement than from the slide valve because with the ancient form of slide valve, in the rotary motion we do not take full advantage of the port area. The valves, being anchored to the centre crank, are not able to open to their full extent quickly enough. One valve port may be open to the full extent, but it is anchored to the other valve which is only just opening, and is throttling the gas pipe so that it is impossible to get the full advantage of the flow of gas through the meter at the higher speed. It is a very highly technical point, but it is well worth considering along these lines if you are looking for a proper capacity meter.

With regard to deliveries up to 106 c.ft. for about 4-tenths in. pressure and 424 c.ft. for an inch pressure, I do not think that is anything startling at all. I do not want to be pulled up for trying to make capital out of an opportunity of addressing the members of the Institution, but if anybody wants further particulars on the subject I shall be very pleased to supply them. There are meters which will deliver 160 c.ft. for the statutory 5-tenths pres-

sure, and we can do that as well for an inch drop if the districts can afford the inch absorption. There is another point with regard to meters; if you have a low district pressure in any particular area, you can often gain several tenths of an inch pressure by putting in meters of a more adequate service and flow. If you have, for instance, to take an extreme case, a three-light capacity meter in a certain district where they are struggling to supply a gas cooker, it requires perhaps 100 c.ft. per hour. That meter may be absorbing an inch of pressure or 4-tenths of an inch. In that case, if you were to take it out and put in an adequate meter, it would supply 80 c.ft. or 100 c.ft. an hour with 4 or 5 tenths pressure loss. Then you will gain straightaway at least ½-in. pressure for your district use.

Distributing a 280 B.Th.U. Gas.

With regard to the rust question, I should like to mention my experience in distributing a 280 B.Th.U. gas. We have not very many cases in England where that is done or where engineering practice is silly enough to do it; but there is one case, and when we made an analysis of the rust which was taken from these pipes I was rather surprised at the high percentage of iron. I wondered if there were any mains left underground at all. I think the iron represented about 85 p.ct. of the rust; and it was simply appalling. Of course, we were working at a very high pressure, somewhere about 20 lbs., and at load times 25 lbs. Under theoretical conditions that was supposed to be fairly dry; but when we cut off a main we found a little heap of rust would blow forth from the open end, and if our men were thoughtless enough to put a pump on to a service we simply had to cut it out. There was no use trying to wire the service or do anything else, because it was simply a stick of iron. I am mentioning all this because the President asked whether the gas was dry. I do not think dry gas has very much to do with our distribution troubles in that respect, because my own experience shows that you can get the rust difficulty, and it will cause you much more trouble than your old enemy, naphthalene, in any case.

As to the wet type of meter, there is no doubt the old form of wet meter which was improved upon by Mr. Crossley was the most reliable that we could possibly have on any district, and the percentage of error was very low indeed. The introduction of the 5 p.ct. toleration was really intended to meet the case of the wet meter, and it certainly met the case; and we were able to test at the high and low water line, which gave us the compensating losses. We had to test at the low water line, which gives us 3 p.ct. slow, and 2 p.ct. fast in the case of the high water line. Then that water line is adjusted automatically by the float valve which is in the meter, so that, if the water falls to a certain extent, of course, the gas main is shut off, and your meter cannot possibly register more than 3 p.ct. slow. Therefore, I do not like a slur being cast upon the old wet meter. I am sure that if we had more of them on the district we should probably get more equable registration when compared with the station meter, which is usually a wet meter. If anyone would like more information about the improvements in actual flow and absorption of pressure in high capacity meters, I shall be only too pleased to help at any time.

The Author's Reply.

Dr. Schutte in the course of a brief reply to some of the points raised in the discussion said: I should like to thank the President for the very kind words he has said about me and my small contribution to this meeting. I also would like to thank those gentlemen who have taken sufficient interest in the paper to discuss it as they have done. I am afraid I cannot answer all the questions now, because my lack of knowledge of the English language has not enabled me to absorb all at once the meaning of the questions that have been put. There are, however, some things I wish to answer, and there are others which Dr. Anderson will be good enough to answer for me. One of the speakers asked about the question of wet meters *versus* dry meters. In our works at Bremen 10 or 12 years ago 80 p.ct. of our meters were wet, and I felt at that time that the wet meter was the most reliable gas meter you can have, and the best measuring instrument. Since then, however, we have found difficulties, because a consumer wishes, perhaps, to use a cooker for a long period. For instance, he has a 5-light wet meter, and finds that he cannot use the cooker to the extent he wishes. Then, perhaps, he adds a geyser, and the geyser will not work, or the other apparatus will not work if the geyser is alight, because the wet meter cannot be overloaded. For this purpose dry gas meters having very high capacity have been evolved which can be connected to every domestic premises, and then various appliances can be added without it being necessary to change the meter. In every way a change of meter costs a lot of money both to the consumer and to the undertaking; and, therefore, from this point of view alone, I now prefer the dry meter.

The last speaker, who is a gas meter manufacturer, has asked for certain information which I cannot give him now, but I shall be pleased to send him details of these meters when I get back home.

With regard to the protection of mains against corrosion, I may say that I saw some weeks ago something quite new at the Mannesmann Tube Works in Dusseldorf. It was a new process for protecting mains which may probably be a very good thing. A speaker asked about the protection of mains from corrosion due to the soil. I believe the experience of which he told us is encountered in other towns, and that the covering of bitumen is not always the best because it is sometimes too hard and cracks, and the mains are exposed to the liability of corrosion. In Bremen, and also in Berlin, we use a bandage called "Denso." I do not know if it is used in England, but it has given very satisfactory service in Germany.

Dr. G. W. Anderson: Dr. Schütte has asked me to give one or two explanations of certain facts which he feels I might be able to interpret better than he himself. A point which Dr. Schütte wishes me to refer to is the difference between a domestic and service governor. In Germany a domestic governor is installed on the inlet of every consumer's meter, and it has served a very valuable purpose, because until recently the gas consumption per head of population in Germany was roughly only one-third of that in this country. There are a large number of people in Germany living in the tenement houses which are so popular there, and the mains have been found in many cases to be inadequate. The gas undertaking, therefore, has been faced with the problem of either laying new mains or else increasing the pressure; and the means which Dr. Schütte has referred to in his paper have been adopted. There may be 40 or 50 meters in one block of tenements. These tenements are of the better-class type, and the difference in the circumstances there and in England demonstrate the difference between the domestic and the service governor. While in this country the service and domestic governor is practically identical, the question in Germany is whether one or the other should be put in.

With regard to meter design, recent developments in Germany have shown indeed that the poppet valve meter is superior to the slide valve meter, as mentioned by a speaker this afternoon, but owing to the enlargement of the slide valve the German meter manufacturers have overcome the initial disability of the dry meter in using a pressure of some 10 mm. or more by reducing it to something less. It is purely a matter of slide valve design; and in improving the design of the slide valve, the German meter manufacturer has overcome the disadvantage of the partial opening of the slide valves. Therefore, I understand from Dr. Schütte that the slide valve and poppet valve meter are now more or less identical so far as resistance and capacity are concerned. The conditions vary considerably, but Dr. Schütte wishes me to say that he can, by employing a 5-light meter, meet practically all the requirements of the German domestic consumer, instead of having to install a larger meter. I think these are all the main points that I can deal with now.

The President: I feel sure that I shall be voicing your wish if we at this stage express our very great gratitude to Dr. Schütte for coming over to England and presenting his excellent paper to this Conference. I am sure it must have been quite a mental effort to Dr. Schütte to explain his paper in such intelligible English, and I am sure we all feel very grateful and would like to express our very great thanks to him.

The vote of thanks was carried with acclamation.

The Semi-Direct Recovery of Ammonia in Gas-Works Practice and the Recovery of Tar Acids from Ammoniacal Liquor

By ALFRED L. HOLTON, M.Inst.Gas E.,

Chief Engineer, Manchester Corporation Gas Department.

INTRODUCTION.

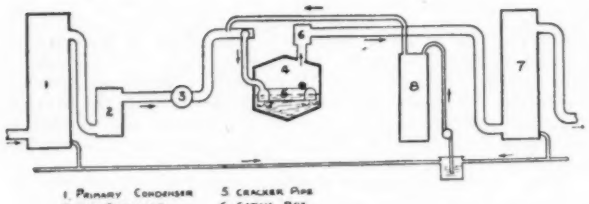
The purpose of this paper is to place on record the experience gained at the Partington Gas-Works of the Manchester Corporation in the starting up and working of a semi-direct ammonia recovery plant, together with the scheme adopted for the treatment of the ammoniacal liquor to ensure a purified effluent.

The latter problem was acute since the works under consideration are situated in a country district far removed from any sewage system. This consideration was one of the deciding factors in the adoption of the semi-direct process, since there would be a minimum amount of ammoniacal liquor to be treated.

As this is the first typical gas undertaking to embody what has been the usual coke oven practice for a number of years, the difficulties encountered and the solution of them will, it is hoped, be of more than ordinary interest.

In the first instance, however, it may be an advantage to set forth the underlying principles of the semi-direct process, and these are shown in the diagrammatic sketch below.

FLOW DIAGRAM "A" OF SEMI-DIRECT AMMONIA RECOVERY PROCESS.



The gas, after preliminary condensation and removal of the tar fog, is passed direct from the exhausters to the saturator, where it comes into contact with sulphuric acid, the ammonia present forming ammonium sulphate. From the saturator, the gas passes through a final cooling process, and then to the purifiers. The virgin liquor from the retort house, together with that which is condensed in the primary and secondary condensers, is distilled in the ordinary manner, and the ammonia gas introduced into the stream of coal gas passing to the saturator.

DESCRIPTION OF THE PLANT.

The whole of the plant erected at the Partington Works was let by contract to W. C. Holmes & Co., Ltd., who entrusted the turbo-exhausters to The Bryan-Donkin Company, Ltd.

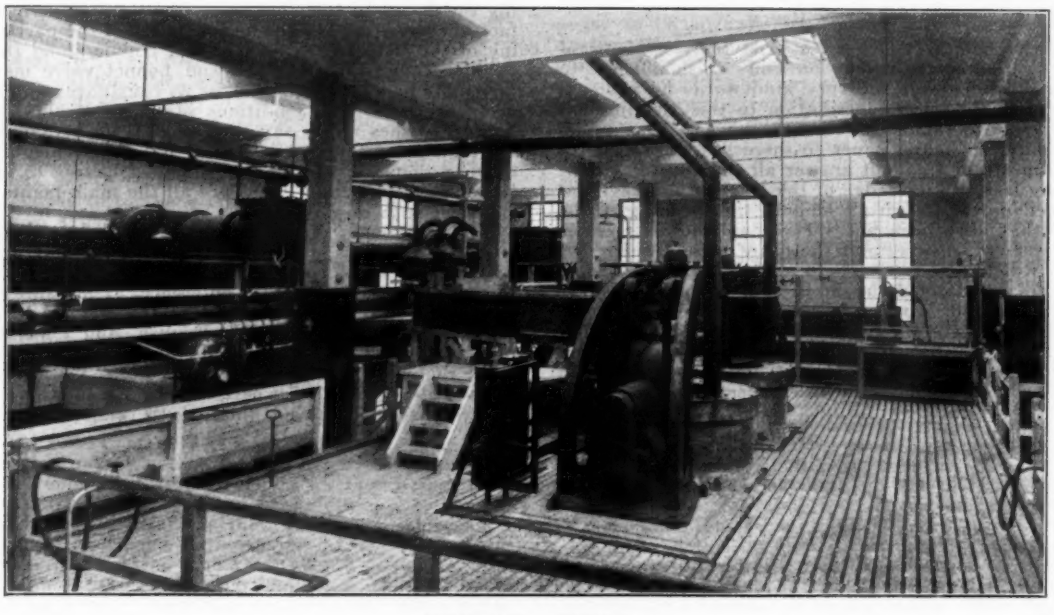
The various units along the gas stream comprise:—

1. Primary condensers.
2. P. & A. tar extractors.
3. Exhausters.
4. Meters.
5. Saturators.
6. Catch boxes.
7. Gas and ammonia by-passes.
8. Secondary condensers.

The remaining sections of the plant follow the usual practice, and, since they do not call for any special comment, are not enumerated.

The carbonizing plant at Partington consists of a 5-million Drake's horizontal installation with a 5-million Glover-West vertical installation, and the recovery plant is capable of dealing with the maximum make or any part of it.

Primary Coolers and Tar Extractors: These follow the accepted gas-works practice, with the possible exception of the P. & A. tar extractors, which, it will be observed, are on the vacuum side of the exhausters.



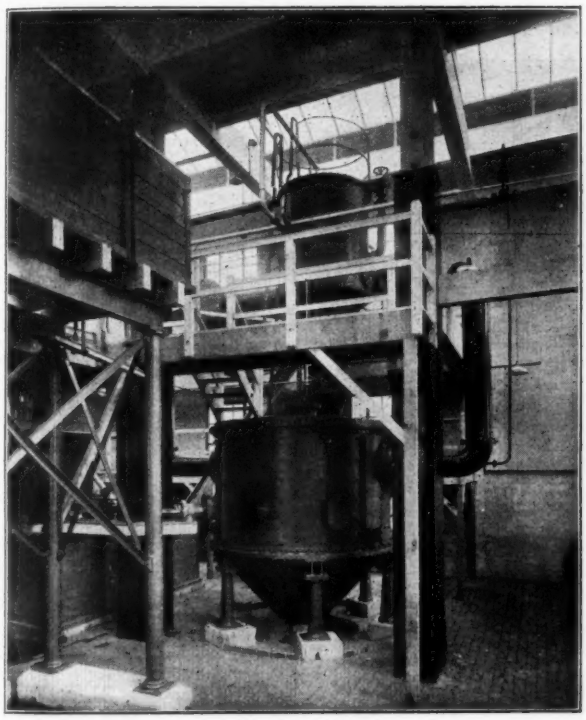
SULPHATE HOUSE.

Exhausters: Three sets of turbo-exhausters are provided, the exhausters being of the three-stage type, each of a capacity of 5 million c.ft. per diem when running at approximately 4000 r.p.m. They are designed to work to a maximum pressure difference of 60 in. W.G. in the gas stream, so as to ensure a margin over the maximum back pressure thrown by the saturator and the remainder of the plant. The exhaust steam from the turbines, at a pressure of 5 to 7 lbs. per sq. in., is utilized for the distillation of the virgin liquor.

Meters: The meters for measuring each stream of gas separately were originally of the ordinary rotary type. They were afterwards replaced by "Connersville" positive displacement meters for reasons that will be discussed later.

Saturators: Three saturators are provided, two 12 ft. 6 in. dia., each of a capacity of 10 million c.ft. per diem, and a smaller one, 9 ft. diameter, of a capacity of 5 million c.ft. for use during the summer loads and reduced make.

The saturators are constructed of M.S. plate, lined with 80-lb. lead, and provided with twin inlets to open-bottom lead cracker pipes.



SATURATOR.

Acid is introduced in the usual manner, and the salt formed is removed by pneumatic ejectors to the draining table and centrifuges.

Catch Boxes: The gas outlet main, which leaves the top of the saturators, is provided in each case with a catch box, which consists of a lead-lined M.S. curtain baffle. This is introduced to prevent any acid spray that may be suspended in the gas stream from being carried forward into the mains.

By-Pass: Between the inlet and outlet mains of the saturator a main by-pass valve is provided. There is also a 3-in. by-pass fitted, the regulation of which permits the requisite amount of ammonia to pass forward for the purposes of purification, and also ensures the neutralization of any entrained acid that may escape the catch box.

Secondary Condensers: The final cooling of the gas before purification is carried out in Holmes super-type water tube condensers, the condensate, or "devil's water," being returned to the liquor wells. These condensers are provided with sprays, which may be used as a wash for the removal of the ammonia from the gas in the event of a failure of the saturators.

Stills, &c.: [The general disposition of the remaining parts of the plant necessary for the drying, elevating, and storage of the salt were shown on a plan, which unfortunately we are unable to reproduce suitably on our page.—Ed. "G.J."]

The centrifugal driers are electrically driven, with a basket capacity of 4 cwt. of salt, and are run at 1000 r.p.m.

While ammonium carbonate is used for the final neutralization of the salt, the principal neutralization is effected in the centrifuges by means of ammonia sprays. A 48-in. propeller fan suspended immediately above the centrifuges ensures the removal of fumes and steam.

The driers are heated by means of air drawn through a coke furnace. Liquor stills are provided in duplicate, and are fed from the storage tanks by electrically driven centrifugal pumps, the liquor passing through rota-regulators.

Air compressors, acid tanks, liming pans, &c., are situated in convenient parts of the building. This building is a reinforced concrete structure, brick panelled, the floor being paved with blue bricks.

THE PLANT IN OPERATION.

Oscillation Troubles.

The usual minor troubles, inseparable from any new plant, were, of course, encountered in starting up, and were soon remedied. There were, however, other vital difficulties requiring immediate attention. The nature and ultimate solution of these difficulties are here recorded.

A new factor in gas-works practice became only too evident from the moment gas was turned into the saturator, for violent oscillations occurred which were communicated to all gauges on the gas stream. The passage of the gas through the acid bath of the saturator set up an oscillation which passed back through the rotary meters and turbo-exhausters to the retort house. The magnitude of the swing at times exceeded 7 in., and the speed of the oscillation approximated to three swings per second. It may be of interest to note that the speed of the oscillation appears to bear some relation to the make of gas.

Satisfactory operation of the carbonizing plant was impossible under these conditions, the exhauster turbine governor being unable to respond to such rapid variations of vacuum. A peculiar sympathetic beat developed between the exhauster governor and the P. & A. tar extractors, and this became so excessive that, at times, the vacuum was lost in the retort house.

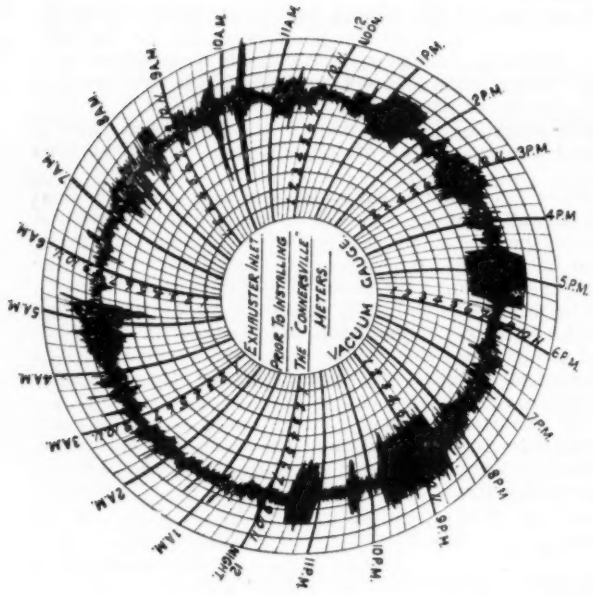
The retort house governors, like the exhauster governors, were unable to respond with sufficient rapidity to such erratic working. As a consequence, gas making suffered, and the rodding of the retorts was accompanied with risks to the attendants. The sympathetic beat between the exhauster governor and the P. & A. tar extractors developed into "hunting," resulting in the P. & A. cages rising and falling so violently that actual damage occurred to them, and the extractor had to be regarded as moving machinery for the purpose of lubrication.

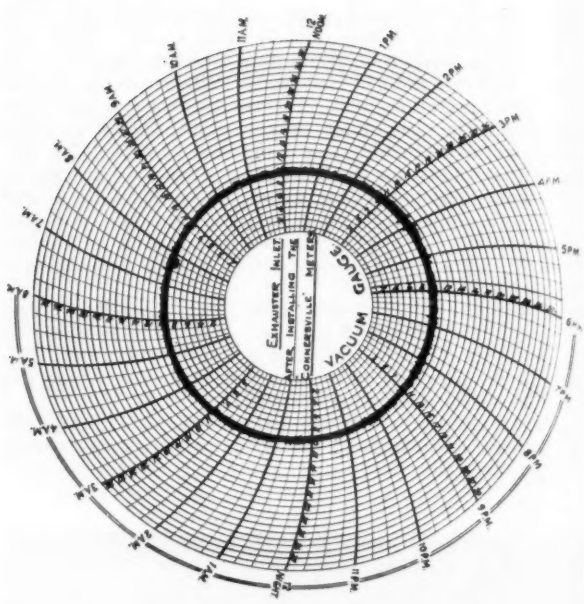
Some measure of control was obtained by "wire drawing" the gas stream by practically closing the condenser valves, but this was accepted only as a temporary expedient, since the position of the valve indicator was confusing, and additional vacuum load had to be carried by the exhausters.

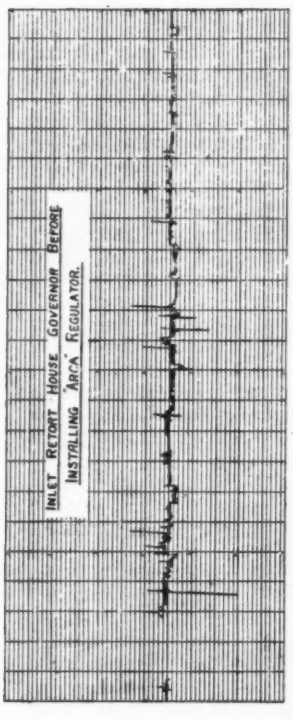
An experiment was then made by connecting up to one of the existing retort house governors an "Arca" hydraulic regulator. The results obtained were so satisfactory (see Fig. 1) that a regulator was also fixed to the other governor.

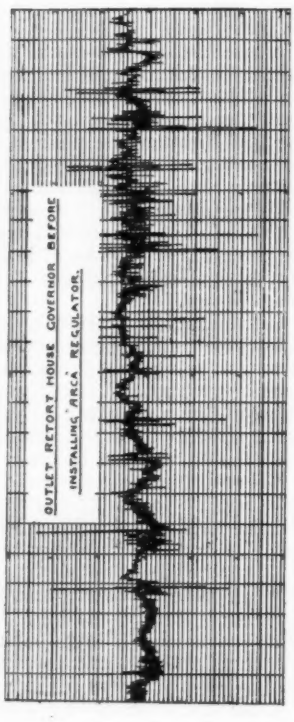
This arrangement considerably improved vacuum control in the retort house, but it by no means solved the exhauster and P. & A tar extractor difficulties.

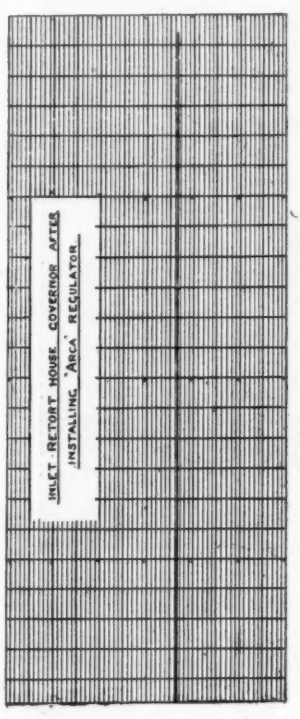
To improve the working of the exhausters, various alterations were made in the position and size of the vacuum pipe of the exhauster governors. No improvement occurred by increasing the size of the pipes to the governor, nor by the alteration of the positions from

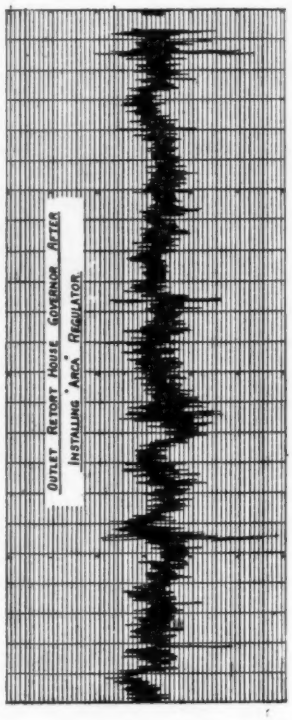












which they were led, but improvements were effected by the substitution of larger governors.

As a result of excessive oscillation, the readings of the rotary meters were naturally unreliable. Efforts were made to overcome this by finding a ratio between the rotary meters and the final " Connersville " meter, but all attempts proved unsuccessful. Since the final " Connersville " meter damped the oscillation, it was decided to substitute a " Connersville " for a rotary meter. This experiment solved completely the difficulty of oscillation from the retort house to the inlet of the meters (see charts (Fig. 1), and a second " Connersville " meter was substituted for the other rotary meter. The oscillation on the outlet side still continues, but this is attended with no difficulties in the working of the plant.

Saturator Problems.

Experiments were next carried out on the saturator cracker pipe by altering the form and size of the slots so as to give better distribution of the gases. A better distribution of acid and mother liquor was attained by drilling holes in the 4-in. acid and mother liquor delivery pipe on the outer side of the cracker pipe.

A more uniform working of the saturator was the outcome of these two experiments.

During the early days of the operation of the plant it was found that even after working for a very short period a serious increase in back pressure occurred, this increase being accompanied by a cessation of the oscillation, and the resistance gradually increased until ultimately the saturator had to be by-passed. On examination it was

found that the saturator was blocked with rock salt, as shown in the photograph.

It would appear that the deposition of the rock salt in the acid bath prevented violent ebullition, thus minimizing the oscillations, and whilst no further work has been done on any alterations to the design of the saturator it is probable that a larger gas distribution area would minimize this trouble. All saturators can, under certain conditions, "rock up," but this first examination revealed that here were conditions that accentuated the trouble, and though every precaution was taken, periods occurred when the saturator had to be by-passed to clear it of rock salt.

When clearing the saturator, it was observed that the greatest formation of rock salt was always at one and the same side of the saturator, and it was further noted in working that one of the gas inlets had a higher temperature than the second inlet, the cooler inlet being that nearest to the side where the blockage was prevalent. This difference in temperature was occasioned by the vapour pipe from the stills entering the common main in such a position that the hot inlet received an undue proportion of the still vapours through inefficient mixing of the two streams. After locating the trouble, the ammonia vapour pipe was extended into the centre of the common gas inlet main, thus ensuring thorough mixing.

It will be noted that the gas is not preheated prior to entering into the saturator. An accumulation of mother liquor took place, even though provision was made for re-heating the circulating mother liquor.

The mother liquor re-heating system was replaced by a lead-lined trough containing a steam heated monel metal battery of Royle's type tubes. The enlarged re-heating system is consequent upon the lower concentration of ammoniacal vapours from the stills, due to the distillation of very weak liquors from the vertical installation. A higher concentration of ammoniacal vapours was obtained by lowering the position of the ammoniacal liquor inlet pipe to the stills, the top portion of the still then acting as a reflux condenser.

Experiments have been in hand during the last few weeks which show that a marked improvement in the working of the saturator is brought about by circulating the mother liquor to a greater extent than with the original ejector system.

Contrary to expectations, tar gave practically no trouble in the saturator, only a trace being found after an extended run. Back pressure, at first attributed to tar, was found to be caused by rock formation in the catch boxes, and the simple expedient of spraying with water twice per shift effected a cure.

Whilst the saturator is working without difficulty, the ideal conditions have not yet been achieved.

Exhausters.

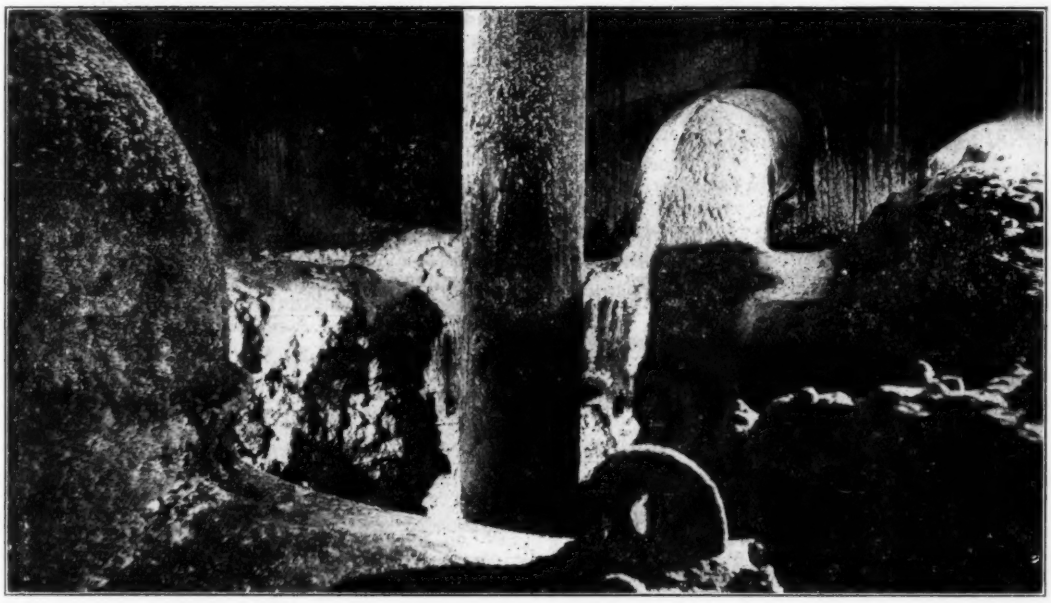
It will be noted that the gas from each of the two retort installations—vertical and horizontal—is kept separate until the outlet of the meters—*i.e.*, until after the exhausters. During the summer months, one of these installations may be working on its full capacity of 5 million c.ft. per day, and the other at only 1 million c.ft. per day. The pull at the inlet of exhauster must therefore vary according to the respective makes of gas, whilst the back pressure is common to both exhausters.

Under these conditions there was a high rise in temperature on the turbo-exhausters working on the light load, which resulted in the pitching of the exhauster casing. A by-pass was therefore taken from the outlet of the final condensers back to the exhausters to enable gas to be circulated in sufficient quantities to overcome this difficulty.

Purification.

Oxide purification has given no trouble due to the semi-direct process. There is, of course, a higher H_2S content than would be the case in the usual gas-works practice, the amount varying from 700 to 850 grains H_2S per 100 c.ft.

The 3-in. saturator by-pass, to which reference has already been made, is adjusted to give a slightly alkaline reaction (approximately 1 grain NH_3 per 100 c.ft.) at the outlet of the second condensers. As a result of the S-D process, there is a freedom from tar fog and oil deposits, thus assisting the process of purification.



BLOCKED SATURATOR.

Normal Working Conditions and Data.

Meters on Crude Gas.

While the "Connersville" meters have given every satisfaction during the past 18 months, it should be noted that two stoppages of the meter occurred on the horizontal gas section when dealing with the reduced summer output. These occurred after the meter had been at work for a period of six months. A gradual increase of differential pressure was observed, and upon examination, a deposit consisting of fine pitchy dust and prussian blue was located on the surface of the impellers. A recurrence of this trouble has been obviated by treating with 3 gallons of hot soap solution every eight hours

in addition to the original lubrication. All the bearings were found to be in good order when the examinations were made.

Saturators—Acidity of Bath.

Working on the batch system, the saturator "strength" should vary from 63° to 58° Tw. or an acidity of 12 per cent. to 6 per cent. H_2SO_4, varying with the make of gas as follows:—

(*a*) 8–10 million c.ft. of gas per day . 10 per cent. to 6 per cent. H_2SO_4
(*b*) 6– 8 ,, ,, ,, ,, . 12 ,, ,, 8 ,, H_2SO_4
(*c*) 3– 5 ,, ,, ,, ,, . 10 ,, ,, 6 ,, H_2SO_4
(using small saturator)

The mean differential pressure of the satuator is 15 in. to 18 in. water gauge.

The mother liquor returning to the saturator is reheated to 68° to 74° C. This requires careful regulation, as too high a temperature leads to salting *in situ*.

Stills.

The stills must be worked continuously to give regular saturator conditions. The amount of liquor to be distilled is approximately 42 gallons of 4 oz. liquor per ton of coal.

Gas Temperature Control.

The plant is best worked at the following temperatures:—

(*a*) Leaving primary coolers . . . . 32° C.
(*b*) Leaving exhausters . . . . . 44° C.
(*c*) Inlet to saturators . . . . . 47° C. to 49° C.
(*d*) Outlet of saturator . . . . . 54° C.

Liquor Produced.

(*a*) *Primary Condensers.*

Vertical installation . . . . 54 gallons per ton of 4 oz.
Horizontal installation . . . 16 ,, ,, ,, 6 ,,
Therefore in the ratio of equal proportions the product is 35 gallons per ton of 4·5 oz.

(*b*) *Secondary Condensers.*

"Devil's water" . . . . . 7 gallons per ton of 0·4 oz.

Financial Consideration.

Capital Costs.

In Table I., a comparison is made between the semi-direct and the indirect systems of ammonia recovery. It will be noted that costs have been omitted where plant is common to both systems.

From this comparison it will be seen that in the case of a 10 million works there is a difference in capital expenditure of approximately £5000 in favour of the S-D process. In the case of a large works, the S-D system would have an added advantage to offer—*e.g.*, a 15 million works would require at least one additional washer-scrubber at £2500, whilst the increase in cost of a saturator to cope with 15 million would differ but slightly from that of one of 10 million capacity. It is not improbable that the 12 ft. 6 in. saturator installed at Partington would deal satisfactorily with a 50 per cent. increase in gas load, as is found in the case of the 9 ft. saturator.

Operating Costs.

The cost of manufacturing sulphate of ammonia is

Table I.

FINANCIAL STATEMENT.—*Indirect and Semi-direct Processes for the Recovery of Ammonia from Gas.*

Comparison between the Two Systems of Capital Expenditure required on a 10 Million Cubic Feet per Diem Gas Works.

(*Plant affected by the respective processes.*)

Description of Unit.	Indirect System.	£	Semi-direct System.	£	Remarks.
Washers, scrubbers, &c. . .	Two 5 mill. per day at £2500 =	5000	*Nil*	..	In the Indirect system some form of ammonia washing plant must be provided. For the purpose of this comparison Holmes rotary brush-type are used. Two of 5 mill. c.ft.
Liquor storage tanks . . .	One steel tank, extra capacity over and above Semi-direct process. 500,000 gallons =	2700	*Nil*	..	By reason of the smaller bulk of liquor dealt with in the Semi-direct system, the storage system is not so great as that required for the Indirect process.
Condensers	..	..	..	..	
Exhausters	..	..	..	..	Due to increased back pressure operating on the Semi-direct plant a more powerful exhauster is required. The difference, however, does not materially affect the capital costs.
Stills	..	..	..	..	The stills are in each case similar, but those employed in the Indirect system would have a few additional sections in the free portion of the still.
Saturators.	One 8-ton per day at	650	One 5/8 tons per day One 8/10 ,, ,,	700 1100	The saturators employed in the Semi-direct process are larger and more strongly constructed than those in the Indirect process.
				£1800	
Preheaters, or heat interchangers for liquor to stills and coolers for waste gases .	..	500	..	..	The total heat extracted from the gas is somewhat higher in the case of the Semi-direct system due to rise in temperature in exhauster and heat of reaction in saturator. It should be noted, however, that condensation is not carried out to the same extent in the Semi-direct system before exhausting so that condenser area at this point may be less than in the Indirect system.
Secondary condensers . . .	..	..	Two at £1000 each	2000	
Mains and valves	..	..	..	..	The by-passes, &c., of the saturators in the Semi-direct process may be taken as the equivalent of those necessary for the scrubbers in the Indirect system.
Sulphate house and stores . .	..	..	..	..	
		£8850		£3800	

Difference in favour of the Semi-direct process, £5050.

similar under both systems in the following items, assuming that both processes are worked with equal efficiency:—

Sulphuric acid.
Lime.
Fuel for drying the salt.
Power costs.
Neutralization costs.
Supervision.
Repairs and maintenance.
Water.
Packing and loading charges.

It will be noted that process wages is the only item omitted, and is perforce higher in the semi-direct system, since the saturator and still attendant must be at work every hour that gas making is in progress, whereas under the indirect system the sulphate plant would be shut down every week-end, and at intermittent periods during the summer, working possibly 200 days per annum.

The following shows the cost of labour at two of the works of the Manchester Corporation:—

	Per Ton of Sulphate.		
	Indirect System.		Semi-direct System.
	s. d.		s. d.
Bradford Road	7 6	..	—
Partington	—	..	13 3
Output per annum	3300 tons	..	1900 tons

The attendants are not fully employed on sulphate making on the semi-direct process, and a reduction would be brought about if suitable duties could be found for them in the vicinity of the sulphate plant.

General Observations.

The plant at Partington is now working with every satisfaction, and it may justly be claimed that the semi-direct process is quite suitable and reliable for incorporation into ordinary gas-works practice.

The salt produced is of good quality, being equal to most and better than many salts produced by the indirect process. The annual production amounts to 1900 tons, equivalent to 30·1 lbs. sulphate of ammonia per 1 ton of coal carbonized.

TREATMENT OF THE AMMONIACAL LIQUOR TO ENSURE A PURIFIED EFFLUENT.

The disposal of the effluent liquor from sulphate of ammonia plants has presented to the gas industry in particular a problem of extreme urgency. The general adoption of bacterial treatment of sewage has gone on side by side with the increasing adoption of vertical retorts, the liquor from which contains increased amounts of oxygen absorbing constituents. At the same time the fall in the price of sulphate of ammonia has made its profitable manufacture difficult at the best, and the addition of any expensive process of effluent purification would extinguish all hope of profit.

The whole subject engages the earnest attention of the Liquor Effluents and Ammonia Sub-Committee of the Institution of Gas Engineers, and the process now adopted at Manchester is largely the outcome of a careful study of the data set forth in the various communications issued from time to time.

There is no doubt that the situation would be materially eased if the solution of the noxious constituents in the liquor could be prevented by the adoption of such processes as those indicated by Dr. Bailey, the late Chief Inspector of Alkali, &c., Works. By the early separation of the tar and liquor, the solution of phenolic bodies in the liquor is largely prevented.

Experiments made, at the Bradford Road Works, in which a Crossley fan was introduced into the gas stream before the condensers, showed that a large proportion of the tarry matter present in the gas at that point could be removed. The tarry matter proved to contain a large part of the higher (polyhydric) phenols, and a reduction in the oxygen absorption figure of the resultant liquor followed.

Experiments are also in progress in which it is sought to remove the tarry matter from the gas by means of a tower, or towers, packed with Raschig rings. Substantial reduction in the oxygen absorption figure of the liquor subsequently condensed is anticipated.

Analyses of the ammoniacal liquor at the Partington Works are given in Table II.

It has been found that if the liquor condensed in the retort house and early part of the condenser plant, say,

Table II.

Analyses of Ammoniacal Liquor at the Partington Works.

Test No.	Sample from—	Free.	Fixed.	Total.	Oxygen Absorbed. (4 hrs. at 27° C.) Total.	Due to Higher Tar Acids, &c.	Remarks.
		Gms. per 100 c.cs.			Parts per 100,000.		
1	Retort house draining tank below governors.	0·272	0·830	1·102	1490	458	
2	,, ,, ,, ,, ,, ,,	0·119	1·581	1·700	1720	759	
3	Tar bosh at main inlet to condensers.	0·094	1·746	1·840	2040	812	
4	Condenser, 1st gas taker	0·21	0·21	0·42	1550	692	Inlet temp., 82° C.
5	Condenser, 2nd gas taker	0·31	0·20	0·51	1447	516	Inlet temp., 68° C.
6	Condenser, 3rd gas taker	1·11	0·11	1·22	1307	32	Inlet temp., 60° C. Outlet temp., 32° C.

Typical Analysis of Ammoniacal Liquor from Storage Tank.

Strength of liquor, oz.		3·5
Composition, gms. per 100 c.cs.—		
Ammonia	Free	0·454
	Fixed	0·306
	Total	0·760
Cyanide, calculated as HCN		0·002
Sulphide, ,, ,, H_2S		0·027
Thiosulphate ,, ,, S		0·029
Thiocyanate ,, ,, CNS		0·009
Phenols ,, ,, C_6H_5OH		0·368
Chloride ,, ,, HCl		0·781
Higher tar acids, &c., oxygen absorbed, parts per 100,000 c.c.		89
Oxygen absorbed (4 hrs. at 27° C.), parts per 100,000—		
Due to phenols		655
,, ,, thiocyanate		7
,, ,, thiosulphate		25
,, ,, other bodies (by diff.)		422
Total		1109

up to a point where the first five gallons per ton of coal carbonized, is condensed, separated and circulated, the ammonium chloride content steadily increases by solution and evaporation, while the free ammonia, H_2S, CO_2, &c., pass forward with the gas. For the first trial the circulation was regulated to give a concentration of 14/18 per cent. ammonium chloride. Regulated quantities of the concentrated solution, amounting to 5 gallons per ton of coal carbonized, are withdrawn for evaporation and crystallization. An impure ammonium chloride is thus recovered. Purification is secured either by filtration of the concentrated liquor through sawdust and activated carbon, or by re-crystallization of the impure ammonium chloride. The final salt is of a pale pink colour, and an analysis gave 98·3 per cent. NH_4Cl.

An analysis of the concentrated liquor withdrawn from circulation, as indicated, follows:—

Specific gravity at 60° Fahr.	1·08 (16° Tw.)
Character of liquor	Dark brown, with suspended tarry matter
Analysis, parts per 100—	
Ammonia { Free	0·1
Ammonia { Fixed	8·76
Sulphide, calculated as H_2S	0·006
Cyanide ,, ,, HCN	0·016
Phenol ,, ,, C_6H_5OH	0·75
Thiocyanate ,, ,, CNS	0·04
Thiosulphate ,, ,, S	0·079
Sulphate ,, ,, SO_4	0·08
Chloride ,, ,, HCl	18·89
Oxygen absorbed, parts per 100,000 (4 hrs. at 27° C.)—	
Due to phenols	1335·0
,, ,, thiosulphate	67·6
,, ,, thiocyanate	33·0
,, ,, other forms, including colour-producing bodies	384·4
Total	1820·0

This process of withdrawing from the system, at an early stage, a large proportion of the oxygen absorbing constituents of the liquor (phenols, &c.) would obviously affect the percentage of purification obtained, and, further, since ammonium chloride would not be present in the subsequent liquor, there would be a saving in the amount of lime used in distillation.

After careful consideration of the various proposals for dealing with the effluent from the ammonia stills, it was finally decided to invite tenders for the erection of a dephenolating plant. A request was made by the Klär und Entphenolungs G.m.b.H. affiliated with Otto's Coke Ovens, Limited, for samples to be forwarded for the purpose of examination with a view to ascertaining whether their process would be suitable. As a result of these investigations, and of subsequent negotiations, the Klär und Entphenolungs G.m.b.H. granted a licence to W. C. Holmes & Co., Ltd., of Huddersfield, for the right to erect, in England, plants embodying the process. A contract was then entered into by the Manchester Corporation with W. C. Holmes & Co., Ltd., of Huddersfield, for the erection of a plant embodying the Klär und Entphenolungs process, capable of dealing with a minimum of 20,000 and a maximum of 35,000 gallons of ammoniacal liquor per day, with a phenol content of 0·368 gm. per 100 c.c. The plant is now ready for operation.

Details of the Plant.

Figs. 2 and 3 show the plant in detail, and the following is a general description of the various sections:—

Phenol Washer: This consists of a M.S. column, 46 ft. high overall and 5 ft. diameter. At the top of the column there are arrangements for dealing with the flow of benzole and liquor. The washer contains 48 perforated plates, the benzole being admitted at the bottom and rising through the liquor, which enters near the top of the column.

Separator: The separator consists of a M.S. column, 3 ft. diameter and 26 ft. high, the lower portion being separated from the upper and acting as a reservoir for the dephenolated liquor on the return flow from the filters.

Filters: The carbon filters, of which there are two, are arranged to work alternately. They are cylindrical vessels, 2 ft. 7 in. diameter and 13 ft. 1 in. high, with additional cone sections top and bottom. Two perforated plates are fixed in the filter, the carbon being between the two. The space above the top plate is filled with Raschig rings.

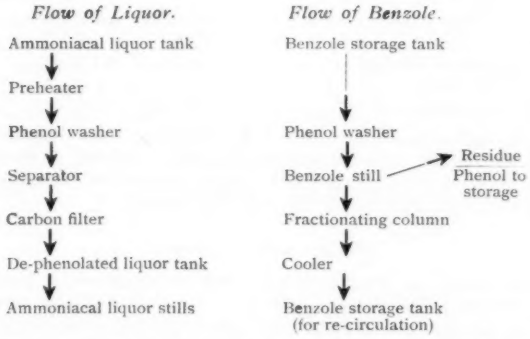
Stills: The primary still consists of a ⏢ shape M.S. vessel, 7 ft. wide, 4 ft. 6 in. high, 26 ft. 3 in. long, and is steam heated. Two sets of steam coils are provided, one for exhaust and the other for live steam. The still has a fractionating column, 5 ft. diameter, 21 ft. 3 in. high, packed with Raschig rings supported on a perforated plate. A dephlegmator is also provided.

Benzole Coolers: The benzole cooler, in conjunction with the active carbon filters, is of the vertical tube type, 2 ft. 7 in. by 7 ft. The benzole cooler, in conjunction with the benzole still, consists of a twin coil condenser with a super-imposed tube condenser.

General: There is also a small secondary still and the necessary storage tanks, pumps, &c.

Operation.

The following diagram shows the flow of the liquor and the flow of the benzole when the plant is in operation.



The clear liquor is treated as soon as possible after production. It is first pumped through the preheater, where its temperature is raised to 60° C., and passed downwards through the phenol washer, where it meets a rising stream of benzole of the following specification:—

Distils entirely between 80° C. and 120° C., and gives 90 per cent. at 100° C.

Here the phenols, &c., are extracted, the treated liquor passing to the separator (to remove the entrained benzole) and then through the carbon filter, which is filled with activated carbon (hydraffin II.). Leaving the filter, the liquor passes on to the dephenolated liquor tank, from which it is pumped direct to the usual ammoniacal liquor stills.

Two carbon filters are provided, working alternately. When a filter shows signs of lowered efficiency, it is taken out of the circuit, and the second brought into service. The spent filter is then treated with steam, and the vapours are passed through a cooler to remove benzole and tar acids. The benzole from the phenol washer, with that recovered from the activated carbon, passes to the benzole still. The benzole is recovered by distillation, and the phenols run off in a continuous stream, through vapour arresters and coolers to storage.

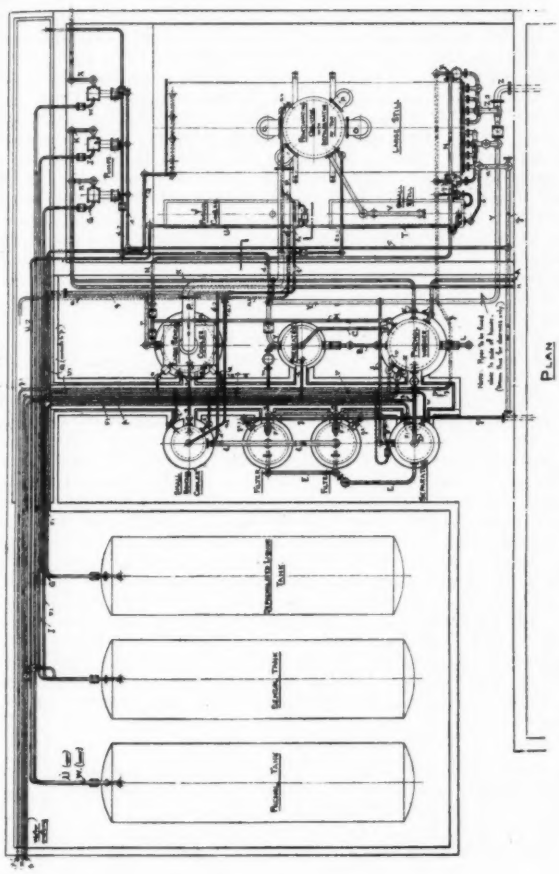
It will be seen that the process combines the general continental (benzole washing) process, with subsequent filtration through activated carbon to arrest the dissolved benzole in the treated liqour. Under these conditions the loss of benzole is guaranteed not to exceed 0·25 gm. per litre of liquor washed.

In ordinary coke oven practice the benzole dissolved in the liquor is ultimately recovered from the gas in the benzole recovery plants. The K. & E. process was adopted for our purpose since it avoided undue loss of benzole in the gas and showed a high percentage of purification of the liquor.

Oxygen Absorption Tests on Treated and Untreated Liquor.

[Four hours' tests at 27° C.]

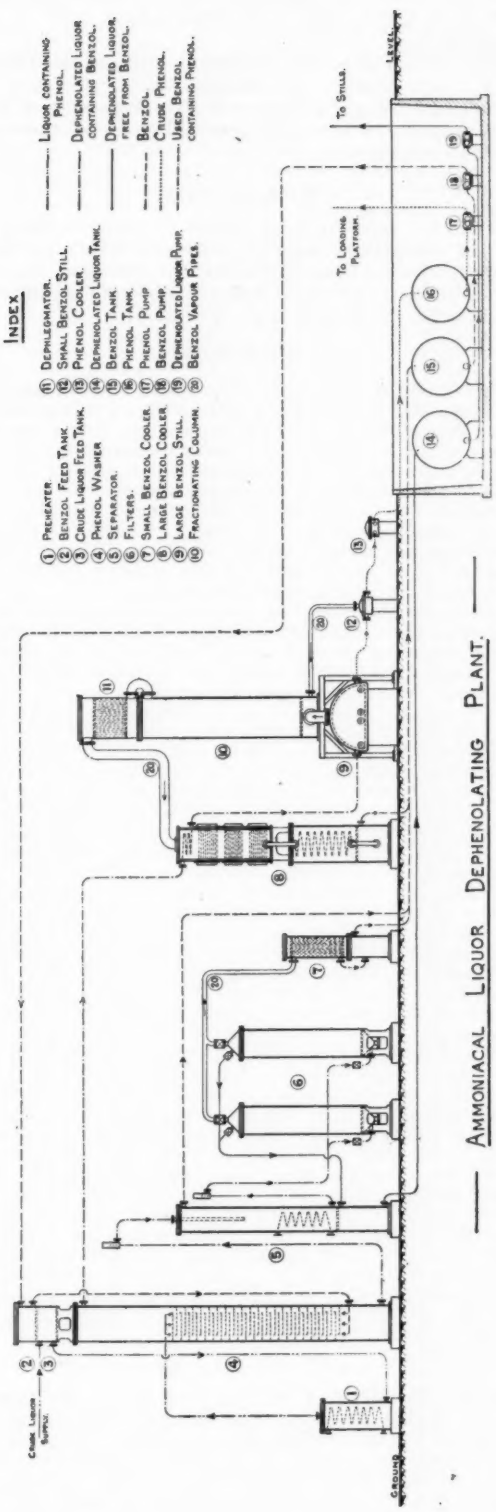
Untreated liquor	1375 parts per 100,000
Treated liquor	160 ,, ,, ,,
Purification	88 per cent.



PLAN

K. & E. DE-PHENOLATING PLANT SCALE 8 TO ONE FOOT

FIG. 2.



AMMONIACAL LIQUOR DEPHENOLATING PLANT.

FIG. 3.

Financial Considerations.

Since the erection of the plant is only just completed, it is impossible to give actual working costs, but, based upon the following data, it is anticipated that the income will cover all expenses incurred.

Capital: The cost of the plant, including foundations, for treating a maximum of 35,000 gallons of liquor per day will be approximately £6000.

Steam: Exhaust steam will mainly be used for the distillation of the benzole, live steam being used only for the final stages and for the pumps. It is estimated that the live steam required will be approximately 16 per cent. by weight of the liquor throughput.

Wages: The process being on a continuous flow system, no actual work is entailed. The supervision necessary will therefore be undertaken by the sulphate attendant.

Benzole: Based on the guarantee given by the contractors, the loss of benzole should not exceed 6·6 gallons per 100 tons of liquor treated.

Carbon: The activated carbon being rather expensive, the question arises as to its life and the annual cost. This, however, must remain an open

question, but investigations suggest that there should not be a great amount of depreciation over a year's working.

Phenols: The recovered phenols will amount to 21,000 gallons per annum, and, calculated on a basis of 1s. 6d. per gallon, will give an income of £1575. It is anticipated that this sum will cover all the various working expenses.

Working Data.

When the plant is in operation, detailed working data will be submitted, together with any other particulars desired, to the Liquor Effluents and Ammonia Sub-Committee of the Institution of Gas Engineers for publication by them for the benefit of the Industry.

DISCUSSION.

Mr. H. D. Madden (Cardiff): About a week ago I was asked by Mr. Holton if I would speak on this paper, and he very kindly sent me an advance copy; but I am afraid I cannot add very much to the discussion to-day, because, when I received his paper, Nature in our part of the country played us a dirty trick, so much so that we had 4½ in. of rain in two hours, which flooded out the whole of my works, and kept me at work day and night. I have had very little rest since, with the result that I have not been able to give proper attention to the paper to enable me to open the discussion in a suitable manner. So far as I was able to read the paper, however, I must congratulate the author on the very able manner in which he has prepared it. There are several facts in it which have interested me very much. The first one is the question of oscillation which has been overcome by the introduction of "Connersville" meters. The other is the formation of rock salt. I think to all of us who have been makers of sulphate of ammonia, this question of rock salt is a difficult problem. I have had some experience of it; and the only suggestion I can make is that there must have been some cause due to local alkalinity at that point. I think Mr. Holton has put his finger on the question when he speaks of the difference in the ammoniacal liquor from the vertical retorts as compared with the horizontals. There is just one other point that occurred to me while the author was introducing the paper; and that is one uppermost in our minds at the present time—namely, the price of sulphate of ammonia and the cost of the installation that Mr. Holton has put in at Manchester. Most of us who make sulphate of ammonia are rather troubled at the very low price we get for it as compared with the price we have to pay for the acid for making it. I have tried, and several other engineers in our vicinity have also tried, to induce the I.C.I. to bring the price of acid to such a figure that it will be possible for us to make sulphate of ammonia not at a loss, but under conditions in which we can just make the whole thing pay. There is very much ammonia at the present time going to waste, and, from what I can see, the problem is that we shall have to put a great deal more ammonia to waste, either in quenching coke or by evaporation or by some other method of getting rid of it, rather than to conserve it for the good of the nation. The one real point, however, that I seem to have grasped from the paper is whether the cost of installing the semi-direct process is compensated for in the price that is obtained for the material made in the plant. Perhaps the author will let me have some information on that point.

"Not a Lead for Gas Engineers."

Dr. E. W. Smith: I am sure that all gas engineers will be pleased that Mr. Holton has been sufficiently progressive to try out a process which has been discussed by engineers for a good many years as possible of application to the Gas Industry. Reading the paper through carefully—Mr. Holton is a very close personal friend of mine, and I am not going to be called anything but candid—I think that if Mr. Holton were to own up he would be prepared to say that he is not yet in a position to give us a lead in the Gas Industry as to whether it is advisable in general circumstances to adopt the semi-direct process or not. The Ammonia Committee made a statement running into some ten or fifteen lines; I will not read it all, but it wound up by saying "It must not be overlooked that these processes are limited to the production of sulphate of ammonia only." At the present time it is difficult for any gas engineer to decide what is the proper thing to do with ammonia, and to tie yourself at this time to the extent of the capital necessary on a process which is limited entirely to one salt would not seem to me to be advisable. Please understand me, I am not criticizing Mr. Holton and his policy, or anything of that kind. I am just trying to indicate that this paper cannot be a lead at the present time for gas engineers to go in for semi-direct recovery of ammonia. If Mr. Holton had had the opportunity or perhaps the foresight to get hold of a competent coke-oven operator prior to the design of this plant, and prior to starting it up, I think he will agree with me that he would not have had any one of the troubles he has met with during its development.

Going through the paper very carefully, one notes that in every instance the difficulties that have arisen might very well have been overcome or anticipated if the coke-oven industry had been taken advantage of by using the experience of a first-class operator—not an exceptional operator, but just a competent operator.

Rock Salt Formation.

Taking one or two of the points almost anyhow one would say that it is inconceivable that a plant would have been designed which did not include a preheater, that being one of the greatest insurances for preventing rock salt formation, because, if there are three factors which are fundamental in the operation of semi-direct recovery they are: Keep the tar out, see that the gas going to the saturator is at the right temperature and at a constant temperature—and I really do not think it matters if the ammonia varies very much in that case—and, lastly, to see that the acidity in the bath is kept constant over known periods. If the acidity is watched from hour to hour, as it is in ordinary coke-oven practice, then variations in the amount of ammonia going to the bath do not matter. In saying this, however, I do not wish to infer that, having satisfied yourselves on these three points, you will not have rock salt formation. Rock salt formation is present and will always be present if the bath itself varies in its acidity, and possibly becomes neutral or even alkaline. The best way of overcoming that difficulty of circulation within the bath itself, in my experience, is to see that there is good circulation in the bath, and good circulation has been found in standard coke-oven practice to be obtained almost certainly by working at a very much higher back pressure in the saturator itself. I notice that in this plant the back pressure is something of the order of 15 in. Standard practice is up to 39 in., and at 39 in. the velocity of the gases through the serrations is sufficiently high and sufficiently positive because of the big back pressure. You do not get surging to anything like the extent that you do when you work at such a small back pressure—where the pressure builds up to 15 in., drops down to nothing, and then builds up again. If you work with a very much bigger back pressure—say, 39 in.—this difficulty in practice is eliminated. That may mean a slight difference in the design of the saturators because the difference in pressure makes a difference.

Only One Saturator Needed.

Another point is that it has been said in the past—and Dr. Parker mentioned it in his paper a year or two ago—that one of the big differences between the coke-oven industry and the Gas Industry is that there are variations of load which have to be allowed for, and I think Mr. Holton has probably allowed for that by putting in two saturators, a normal size saturator and a smaller size saturator, to take up the difference of load, or it may have been a stand-by. My view is that it is not necessary to work with more than one saturator. I know a plant to-day which, because of the present outlook in the coking industry, is working at 10 p.ct. of its normal load, with the same saturator and with the same results, and without any trouble through rock salt in any way, or intermittent introduction of ammonia gases from the still into the saturator. When it was found to be necessary to work at 10 p.ct. of the normal load, the only thing that was done was to reduce the seal in the saturator from 39 in. down to 14 in., and at the 10 p.ct. load the 14-in. seal was used, while at full load it was 39 in. That has precluded any possibility of trouble on these saturators, so that variations in load do not necessitate a much bigger plant. A further point is that I do not think it is necessary to have a 3 in. by-pass for ammonia, because if the velocities through the serrations are sufficient there will be sufficient ammonia passed from the bath itself and through the bath itself to neutralize any spray that might conceivably leave an acid catch which was properly designed. As a suggestion, I should say that, if there is any development of this semi-direct system, closed secondary coolers do not need to be used. It has been found that open coolers as secondary coolers after the ammonia has been taken out are entirely satisfactory and are becoming standard practice, and they are obviously a little more efficient and a little cheaper to run.

I should like to ask Mr. Holton, with the conditions under which he ran his saturator, how often he killed the bath,

Did he work up to 15 p.ct. acidity or 10 p.ct. acidity, and how often did he come back to that acidity, and at what acidity did he maintain the bath in between periods of cooling, because we have met certain troubles due to the formation of resins after the saturator? One has found that, to kill the bath once in 12 hours to 10 p.ct. acidity, and then maintain, in between these periods, a 5 p.ct. acidity, seemed to give entirely satisfactory results.

Another point is that it is standard practice in the coking industry to use the water wash in the catch boxes as a regular thing, and also to wash out the saturators with water as a regular thing, so that what Mr. Holton found to be necessary is standard practice.

Question of Capital Cost.

Finally, there is the question of capital cost. In my view the overall capital cost of semi-direct recovery should be lower than that of the indirect system; and if, of course, it was found not necessary to put in two stills—one still being standard practice, and one standard still being quite reliable—and if you were to cut out all but one saturator, that would bring down the capital cost figure very materially. In my experience the labour costs as indicated by Mr. Holton are about 5s. higher than they ought to be. A figure of 9s. per ton of sulphate should be the outside limit, and is the outside limit in coke-oven practice, so that there should not be a difference of more than 1s. between the indirect system and the semi-direct system. Nevertheless, I think the Industry is to be congratulated on having Mr. Holton at Manchester. Last year he gave us the results of the Trefois producer. This year he has given us the results of the experiments on this semi-direct process. The Industry is to be congratulated on Manchester daring to go into some of these newer things and putting forward with great pluck not wonderful results, but the mistakes they have made, in order to prevent others making the same mistakes, and I personally thank Mr. Holton very much for coming forward in the plucky way he has.

Dr. A. Parker: Dr. Smith's lengthy contribution has left me very little to say, but I would like to express my appreciation of the enterprise of Mr. Holton and his Gas Department in putting in two plants—namely, the semi-direct process for the recovery of ammonia and the plant for the recovery of phenol—as commercial scale plants which at this stage are bound to be, as far as the Industry is concerned, something in the nature of an experiment. Without, however, enterprising men of this kind, we cannot expect to advance. Mr. Holton has brought forward the troubles experienced with the semi-direct process as tried at Partington; and it is mainly from mistakes that improvement is eventually obtained. So many papers bring forward their good results and leave out descriptions of the trials and troubles encountered in reaching that end, but it is really the trials and troubles in getting the good work done that are the most valuable part of the experience in the early stages. I note, however, that Mr. Holton promises to bring forward results of operation of the plant as soon as they are available. I look upon this paper as a preliminary paper, and as a very good preliminary to a later paper describing the results obtained with both stages of the plant—the ammonia side and the phenol side—as soon as sufficient experience has been obtained.

Fluctuation in Gas Flow.

Mr. Holton has referred to blockages of rock salt, and how he endeavoured to overcome difficulties which may arise from fluctuations in the flow of gas. That point of the fluctuation in the flow of gas was brought out in my section of the Report to the Ammonia Committee, because in most coke-ovens the amount of gas passed through the saturator does not vary a great deal from time to time. Latterly, as Dr. Smith has said, there has been experience of running the semi-direct process in conjunction with coke ovens with large variations in the amount of gas produced. It would appear that there would be no difficulty with correct design of cracker plates and correct pressures. I was rather surprised to hear from Dr. Smith of the vast back pressure he used in the saturator, the figure being as high as 39 in. Without having gone into the matter during the past year or two, my own impression would be that one could work at a lower pressure with the right design of cracker plate for that pressure. It is a combination of design and operating pressure which really counts. Then there should be no large oscillations in pressure running back to the foul gas main.

Cost of Operation.

Reference is made in the paper to the question of cost. I touched on that in a very general way in the Report to the Ammonia Committee, as far as it was possible, taking into account the very different lay-out of plant required at different works and also the speculative side of the problem at that time, whether two or three saturators would be required or whether a fluctuating gas load could be allowed for with one saturator; and I rather came to the conclusion that there was very little difference between the cost of manufacturing sulphate of ammonia by the indirect process, the direct process, or the semi-direct process, taking everything into account. I hope that if Mr. Holton comes forward at some future date with results to the Ammonia Effluents Committee or direct to the Institution, he will be able to give a detailed analysis of the cost of making sulphate of ammonia by the semi-direct process compared with the cost involved when using the indirect process.

In his list of operating costs, Mr. Holton includes " power costs." I take it that he refers only to the power costs for operating the still and purely the ammonia side, but one must take into account the extra power required to carry the gas from the foul gas main through the subsequent plant, including the saturator throwing a fairly large back pressure. The exhausters are bound to require more power, and therefore the running costs are bound to be higher for the semi-direct than the indirect system. That requires to be taken into account. Two balance-sheets would require to be drawn up for the two systems and comparisons made. I gather that one reason for the selection of the semi-direct process at Partington was that it was hoped thereby to reduce the difficulties of solving the effluent problem—a problem which, at Partington, as many of us know, is an acute one. By using the semi-direct process the volume of effluent liquor required to be disposed of would be less than when using the indirect process and using water in the scrubbers; but one can avoid the use of large quantities of it in gas scrubbing in the direct process, and keep down the cost in that way. However, that was one reason for the selection of the semi-direct process.

Recovery of Phenol.

With regard to the process for the recovery of phenol, more than 50 p.ct. of the oxygen-absorbed value of the effluent liquor is due to phenols and higher tar acids in the case of the indirect process of ammonia recovery, but in the semi-direct process the larger proportion of the oxygen-absorbed value is due to naphthalene and the higher tar acids, and, therefore, there is some point in trying to recover the phenols. I rather gathered that the phenol recovery plant is not yet in operation, but will be very shortly; and I have no doubt that Mr. Holton will be glad to come along and give particulars of the operation of this plant, again quite frankly describing any difficulties which have arisen. I think no doubt there will be difficulties and that a certain amount of experience will be required before the conditions of generation and the best type of carbon filter to be used will be found.

Mr. D. M. Henshaw: In the first place I should like to say I think Mr. Holton is to be congratulated on the fact of having had an opportunity of bringing before this meeting a paper describing the working of the process under conditions which, so far as I know, are new from the point of view of the employment of semi-direct processes on gas-works. There is a point also to be remembered, and that is, the decision to install the semi-direct plant was probably made somewhere about 1925, when the price of sulphate of ammonia was considerably more than double the present figure; and although the question of the cost of sulphate making would have entered into the discussion, the question of the disposal of the effluent and the discharge of the effluent was probably the more important point. It has been mentioned that a certain amount of pluck was required to install a plant of this kind and to work it on such a large scale in connection with two kinds of carbonizing plant—namely, the vertical retorts and horizontal retorts —in which the conditions are quite dissimilar in regard to the gas made, and having in mind also that the two streams of gas are collected together and mixed before saturation.

An Established Plant.

This plant was almost identical in design with probably ten or more installations of similar size which had been erected in this country prior to the Partington Works being put up. It was a well-known and established design which had been successfully installed also in Germany; and there was no reason why, from the point of view of the design of the plant and the construction of it, it should not have worked entirely successfully without any of the difficulties which have been experienced. As a matter of fact, a similar plant had been working for three or four years and making up to 10 tons of sulphate of ammonia per day. This plant was started up just before the strike, and worked without any of the troubles which have been described by Mr. Holton in the way of rock salt or fluctuations or other difficulties. In fact, the plant I refer to was successful in every respect, and it worked down to 10 p.ct. or less of its capacity during the time when the coke ovens

had to be run on a very low throughput on account of the fact that coal was not available.

I just mention that to make the point that none of these difficulties need have occurred, but they were insuperable owing to the conditions under which the plant had to be worked on a gas-works. With regard to back pressure, mentioned by Dr. Smith, this plant was of the same design as other plants which my firm had built previously, and they have actually worked on a little less back pressure, if anything, than the Partington plant, without any difficulty and without rock salt formation. And inasmuch as back pressure costs money which represents steam consumption on the exhauster, therefore the lower this plant could be operated by way of back pressure, the more efficient it may be said to work. There are points to be considered on gas-works purification which are different from those on a coke-oven plant. There is very little pressure to be encountered after the saturators on a coke-oven plant, but on a gas-works you have the back pressure of the purifiers, and there is the question of the total amount of pressure which can be economically provided for to be taken into consideration.

I also would like to refer to one other point in regard to the question of the design of these plants, and that is the preheater. This particular process, I think, dates back from about 1905 to 1910, and, of course, it was first designed when the question of the semi-direct recovery of ammonia was, one might say, in the experimental stages. The actual question of preheating was considered, and it was decided that preheating of the liquor as distinct from the preheating of the gas would be impossible; and no such arrangements have been made in the previous plants which have been put into operation. The preheater at Partington, however, has fulfilled the requirements in the modified design, and is quite satisfactory.

A Different Angle.

The question of ammonia recovery generally, I think, is one which we are now looking at from an entirely different angle from what we did, for instance, in 1925. The bearing of ammonia recovery and the sale of the ammonia on the price at which you can sell your gas is a very small one indeed in its effect upon the price per therm at the present time, and therefore it is now more a question of what can we do with our ammonia in order to get rid of it at the least expense, both from the point of view of capital expenditure, labour, and the other expenses entailed in either making concentrated liquor or sulphate of ammonia or losing the ammonia altogether. Although this is not relevant to the paper, I think we have to look to some other way of disposing of the ammonia comfortably and without creating a nuisance, without the cost of effluent purification or treatment being entailed in order to get rid of this troublesome impurity in the gas. The conditions under which sulphate is marketed at the present time are, one might say, a matter of political economics, inasmuch as various governments of the world have decided that the kind of plant which they are now working for the synthetic production of ammonia is necessary to their security, and therefore we cannot hope in the future, unless some other entirely new and at present unknown use for ammonia is discovered, that the conditions will very much improve. Therefore, as I say, I think we must look to still further research and investigation to discover means of getting rid of ammonia.

Metering of the Gas.

One other point, and that is the question of the metering of the gas which Mr. Holton has described. It should be made clear that there are actually at Partington three meters altogether; one serves the function of an ordinary station meter, and takes the whole of the gas after purification. The other two meters which have been installed are metering separately the hot gas before entering the separators, after leaving the exhausters from the vertical retort plant, and from the horizontal plant; and taking into consideration the difficulties which are entailed in balancing one against the other due to the difference in pressure and temperature, the results obtained, I believe, have been consistently good. It is, of course, not possible to check against other types of meters in that case as to whether these meters are functioning satisfactorily from the point of view of the measurement of gas, but as many of you know, during the past three or four years "Connersville" meters have been installed and these meters have for long periods been checked for accuracy of registration for varying capacities and speeds against the older type of drum station meter, and have been proved to be consistently accurate under all practical conditions. I do think that the question of ammonia recovery is one which is destined to be a very interesting study; and the work of the Research Committees engaged on this subject will well repay the expenditure of time involved, to get over the troubles with which we are beset at the present time, and even to avoid, if possible, the necessity for having to treat effluents by the discovery of some means for getting rid of the effluent and ammonia altogether.

The President: I will call on Mr. Botley, the Chairman of the Ammonia Effluent Committee of the Institution, to say a few words.

Mr. C. F. Botley (Hastings): In the summary of the last Report of the Ammonia Committee it was suggested that the semi-direct and the direct processes were worthy of further consideration. At that time, of course, we knew of the Partington work, and therefore we are greatly indebted to Mr. Holton for having come forward and given us the information he has done. He is no doubt making the best of the plant which is provided there, and has anticipated and overcome difficulties which he was led, perhaps, to expect from work which had been done on behalf of our Committee. I want to be quite clear that the chloride of ammonia process which Mr. Holton refers to in his paper is only a suggestion, and is not a practical question at the present time. Another point I want to mention is that it should be made clear that Mr. Holton is purifying the liquor or dephenolizing the liquor before it goes to the stills, with the result that he gets an effluent from the stills which may be taken for other than what it is. It is interesting because obviously that should be possible to be used for quenching, and also it is very interesting because it reminds me of the suggestion which we have before the Committee that we might use this liquid for steam raising. The only other remark I would like to make is that I appreciate very much on behalf of the Committee the kindly reference Mr. Holton has made to the work with which we have been entrusted, and also thank him very much indeed for his promise to collaborate with my Committee in its future work with regard to dephenolizing plant. These plants are only applicable to large centres of liquor handling, but we are greatly indebted to Mr. Holton, and look forward to further co-operation with him in the general cause.

Life of Carbon Filters.

Dr. A. C. Monkhouse: I should like to congratulate Mr. Holton on his paper, which to me is particularly interesting. The points he has raised for discussion are so many and so varied that I will confine my remarks to those dealing with the treatment of ammonia liquor to ensure a purified effluent. The Report of the Effluents Committee last year contained an account of a visit I paid to the phenol recovery plants in the German coke ovens and of the success they had attained. Experiments have since been made with an experimental continuous washing plant at Coventry. We treated the gas-works liquor with the crude benzole as recovered at the works, and obtained results comparable with those obtained in Germany. The results will be reported at the autumn meeting. As Mr. Holton has pointed out, one of the difficulties of application to gas-works practice is to devise a method of recovering the benzole dissolved in the ammonia liquor. At 15° C. it was in our case—and I speak from memory—of the order of 0·18 gramme per 100 c.c. The Partington plant incorporates active carbon filters for this purpose, and it will be interesting to know what the life of these filters will be. One line of attack we considered to obviate this use of a valuable soluble solvent was the use of tar oils, but difficulties arise with emulsions. Mr. Holton refers to a tower filled with Raschig rings for the ready removal of tar from the gas, to diminish the proportion of polyhydric phenols in the liquor. I should like to know the back pressure thrown by such a tower, and the proportion of the total tar brought down there. We found in the experiments at Coventry that a cyclone tar extractor for efficient working created a back pressure of 1 to 1½ in. The proportion of the total tar brought down in the various systems we have tried has been:

Electrostatic precipitation (Lodge-Cottrell)	91 p.ct.
High-pressure liquor spray	80 ,,
Cyclone tar extractor and liquor circulation	75 ,,

Mr. Holton gives results of the working-up of circulating liquor to a concentrated ammonium chloride solution. At Hinckley Gas-Works, where we worked our circulating liquor to a comparable strength of 7·6 p.ct. fixed ammonia, we obtained a diminution in the monohydric phenols of the liquor as the strength of the NH_4Cl went up. A similar result has been reported by Mr. Hollings and Dr. Pexton, and I am therefore rather surprised at the high figure of 0·75 gramme per 100 c.c. given by the author for the monohydric phenols. In our case the figure was 0·15 gramme per 100 c.c. Later laboratory experiments on tar liquor equilibriums have confirmed the point of decreasing monohydric phenols with increasing ammonium chloride strength. We found, however, a very

high content of polyhydric phenols, and the salt obtained on crystallization turned a deep red colour due to the oxidation of these phenols. Mr. Holton has been connected with the treatment of effluents since his early experiments on bacteria beds in conjunction with Dr. Fowler. Personally, I am very interested in the experiments he has described, and think that his bold treatment of his difficulties merits every success. I should like, in view of my having left the staff of the Institution, to express my pleasure at being allowed to take part in this discussion.

Mr. W. B. McLusky (Halifax): Mr. Holton presents his case with courage and candour. He has followed the recommendations of the late Chief Inspector of Alkali Works (Dr. Bailey) and the Effluents Sub-Committee of the Institution. He has attempted, on a wholesale scale, to apply coke-oven practice to a stream of gas which has to satisfy, under the most stringent statutory enactments, as to quality and purity, the widely varying needs of his consumers over 8760 hours in a year. The primary product of the gas-works process is gas. To supply gas is our work and our responsibility. To supply coke is the primary business of the coke oven. The recovery plants for the distillates of coal at a coke oven function satisfactorily—according to coke oven standards—when the production of gas is in the region of the minimum output of the ovens. And the form of coke-oven recovery plant installed at Partington would, I think, have caused less trouble had it been found practicable to keep the output of gas uniform from hour to hour.

Rock-Salt Formation.

The capacity of the Partington plant is 10 million c.ft. of gas per diem; at times the output has been as much as 30 p.ct. below that figure. This reduction in the flow of gases and consequent reduction in the velocity of the gases through the cracker-pipe in the saturator has been largely responsible for the formation of the rock-salt. The remedy is:

(1) Uniform velocity.
(2) Higher velocity.
(3) A saturator of different design.

The rapidity with which acid and ammonia combine makes high velocity and a uniform hourly flow of gas essential. Without such conditions the acid searches for, and selects, the ammonia; and in Partington the acid found the ammonia oscillating up and down inside the cracker pipe, and formed salts in that confined space.

The late Thomas Holgate's saturator (year 1897) would have helped Mr. Holton tremendously. In Holgate's saturator the gases entered the saturator at high velocity. The gases were divided into very fine streams. The gases, the steam, and the heat generated by the reaction, were co-ordinated so as to produce an active circulation of the contents of the saturator, and the scouring action set up effectively prevented the formation of hard salts.

Purification of Gas.

The purpose of any process of this kind on a gas-works must be to purify the gas, or to prepare it for the final stages of purification. Oxide of iron alone will not, of course, complete the work of purification unless the gas is properly prepared before it reaches the inlet to the purifiers. Long before we gave up lime purification, Wm. Young, Henry Aitken, Livesey, Hill, Holgate, and others searched for a substitute or an alternative means of finishing the work of purification.

Holgate made great progress in practice with his well-known liquid purification scheme; and the purification of gas at Hailfax to-day, if less costly to work, is really a development of Thomas Holgate's work.

Effluent-Purification.

The purification of effluent liquors, the "washings" or "dregs," however important—and we acknowledge the tremendous importance of this work—must always be secondary. These washings must be made fit to enter the sewers without reducing the activity of the bacteria in the sewage beds, but this can be done without elaborate or expensive plant, and without interfering with or interrupting the work of gas manufacture which is our job—our legitimate work, our statutory obligation. We accord great credit and praise to Mr. Holton for his magnificent work, which is a most valuable contribution to our knowledge. Out of this work will emerge a solution of the problem of purification. But I have a notion that our ultimate success will not be in the treatment of foul gas with clean acid, but in the selection of acid at the source, from the stream of gas before it leaves the retort house. Till this is accomplished we must persevere in the work of reducing the H_2S content by the judicious use of liquor in the retort house, and in the washing plant. Proceeding cautiously on these lines, the H_2S entering the purifiers in Halifax seldom exceeds 300 grains per 100 c.ft. of gas made.

Mr. F. Firth (Leeds), in a written communication, stated: I notice that a Crossley fan fixed at the inlet to condensers at Bradford Road removed the fog and reduced the oxygen-absorption figure. In the experiments carried out by Dr. Monkhouse with the Lodge-Cottrell tar extractor, the oxygen-absorption figure was actually increased by removing the tar fog above the dew-point of the liquor. Can Mr. Holton suggest a reason for the differences in the results?

When dealing with oscillation from the saturator, was the installation of an "Arca" regulator immediately in front of the saturator considered? Judging by its performance in levelling-out oscillations on the retort side of the governor, the possibilities are that it might be successful at the saturator. I notice that liquor is circulated until a strength of 14-18 p.ct. of ammonium chloride is reached; and I would like to ask if at this strength equilibrium has been reached between the chloride in the liquor and in the gas, and if so what is the temperature?

With regard to the extraction of phenol with benzole, charcoal filters are used to remove the last traces of each, and I suggest that if the solubility of benzole in liquor exceeds 40 parts per 10,000, the work of the filters will be greater than direct removal of phenol by active carbon omitting the benzole. Can Mr. Holton tell us what are the objections to direct recovery by active charcoal? I venture to suggest that the work of Hollings, Pexton, and Chaplin on active carbon will prove invaluable to the author should difficulties arise with the carbon filters.

The loss of benzole is exceedingly small. Does this refer to the actual benzole taken out of circulation, or is credit taken for the B.Th.U. put back into the gas stream from the dephenolated liquor?

The discussion was closed at this stage, the President asking for written contributions from others who wished to take part in it.

A cordial vote of thanks was passed to Mr. Holton for his paper.

Mr. Holton's Written Reply to the Discussion.

I am pleased to note that one or two speakers refer to the paper as one dealing with difficulties. This aspect of a paper has evidently been a great surprise to many, for one speaker refers to it as "pluck."

I wish to reiterate my statement "that the plant at Partington is working to our complete satisfaction," and this fact is coupled with a high percentage recovery of ammonia. I therefore cannot understand how Dr. Smith could make the statement "that I was not yet in a position to give a lead to the Industry on the advisability of adopting the process." When a new works is being erected, the form in which the ammonia is to be recovered must be decided upon, or a much higher capital expenditure must be incurred for the flexibility of ammonia recovery required by Dr. Smith.

Mr. C. F. Botley stated that the Ammonia Committee were of the opinion that the semi-direct and direct processes were worthy of further consideration in the Gas Industry, and he will be pleased to know that this observation was the reason for the first portion of the paper. Dr. E. W. Smith is not of this opinion, for all the knowledge required of the semi-direct process has been acquired in the Coke Oven Industry, and it was only necessary to apply the process in all its bearings to ordinary gas-works practice, and it would be a complete success. Has he never experienced difficulties in the starting-up of a process, or may I infer that previous inquiries have eliminated all troubles?

Other speakers, however, differed from his point of view, and emphasized the fact that differences between the two Industries do exist. It must always be borne in mind that in the Coke Oven Industry the main factor is the production of a good quality coke, whereas in the Gas Industry the production of gas is the essential feature. It is becoming increasingly recognized that the amount and regularity of pull on the retorts has a vital bearing on the results obtained, particularly with vertical installations, where it is a question of working to fractions of 1/10th variation. So far as I am aware, such stringent conditions are not required in coke oven practice.

I note that Dr. Smith is of the opinion that variations in the amount of ammonia going to the bath do not matter; all that is needed being the pre-heating of the gas, and the maintenance of the right and constant temperature. I fail to reconcile the two observations, for the amount of ammonia going to the bath has a direct influence upon the temperature of the bath. As pointed out in the paper,

(*Continued on page* 834.)

The Gas Industry in America

By CLIFFORD E. PAIGE (New York),

President, American Gas Association

Introduction.

It is a pleasure and a very great honour to come before this meeting as a representative of the American gas industry. We feel that this is an historic occasion in that it is the First International Gas Conference and the first time the President of the American Gas Association has been privileged to address a General Meeting of the Institution of Gas Engineers.

In addition to the visits, to and fro between the countries, of the personnel engaged in the service of numerous companies, there has been, we are glad to note, a constant and continuing interchange of information. It is therefore peculiarly gratifying to have this opportunity to meet and address so many of you personally and to extend to you the greetings of the gas industry of America as well as its very best wishes for a successful meeting.

Early Gas Associations.

In speaking before such a gathering as this, the members of which come from older countries, I am impressed with the thought that history and long established custom are properly valued and appreciated, and we have noted with considerable interest that the sister organizations serving an industry organized nearly a century and a quarter ago have an ancient and honourable record. For example, while it is doubtless common knowledge over here, we find it interesting that the present German Association of Gas and Water Engineers was organized as the Society of German Gas Men in May, 1859; that the preliminary meeting of gas managers, known as the British Association of Gas Managers (now the Institution of Gas Engineers), was held in Manchester, December 15th, 1863; that in 1873 both the Swiss Society of Gas and Water-Works Men, and the Institution of Gas Engineers in the Netherlands, organized their respective national organizations. In 1874 not only was the first Congress of the Société Technique de l'Industrie du Gaz en France held in Paris, but the Association of Gas and Water Industries in Italy was organized. Some of our predecessor organizations came into existence about the same time, the first meeting of the American Gas Light Association being held in Cleveland, Ohio, in September, 1872.

That the minds of the gas men of Great Britain and the United States must have been thinking along the same general lines is indicated because from November 19th to December 17th, 1904, an International Gas Exhibition was held at Earl's Court under the auspices of an Advisory Committee of the Institution of Gas Engineers. The appropriate Gas Associations of France, Germany, Holland, Belgium, and Italy had several representatives, and in the reception tendered them were included several American visitors. In the same year (June, 1904) a Congress of Gas Associations of America in which ten Associations, Guilds, and Societies participated, was held at the Louisiana Purchase Exposition at St. Louis, Missouri. There, that distinguished leader and great prophet of our industry whom we still delight to honour, Henry L. Doherty, discussed Gas Association work and advocated the formation of a National Gas Association for which at that time the name American Gas Association was suggested.

Later the American Gas Institute was formed from the combined membership of the Ohio Gas Association, the Western Gas Association, and the American Gas Light Association. The Institute was devoted to, and composed of, what might be called the technicians of the industry, so that as a result there later came into being, in May, 1905, the National Commercial Gas Association. The Institute and the National Commercial Gas Association continued serving their respective fields until in 1918 appropriate Committees of each organization agreed to the formation of a new Association to be known as the American Gas Association.

American Gas Association.

As is generally known, the Association comprises the gas companies, the manufacturers of equipment and appliances, and individual members; its affairs are administered by an Executive Board which, when the Annual Convention is not in session, exercises exclusive jurisdiction over all affairs pertaining to its management, together with a permanent staff. The latter, specialists in every phase of the industry, are under the immediate direction of a Managing Director, and are located in New York City; Cleveland, Ohio; Dallas, Texas; and Los Angeles, California. The work of the Association is carried on by means of Committees (assisted by the permanent staff), which may be " Sectional " or " General," because under the Constitution of the American Gas Association, as at present amended, we have a Natural Gas Department and six Sections, each of which has appropriate jurisdiction over all the matters relating to its respective functions; these are Accounting, Commercial, Technical, Manufacturers, Publicity and Advertising, and Industrial Gas. Each Department or Section is headed by its own Chairman and Vice-Chairman. It will readily be apparent, therefore, that there must of necessity be certain interest and activities of a more general nature than the classifications above listed, and the Association has found it expedient and necessary to organize what we know as General Committees.

We believe that the cumulative effects of the co-ordinated and co-operative efforts put forth by the numerous component parts of our highly ramified industry have more than justified the creation of the Association. The representatives of all phases of the industry's activities serve together on the appropriate Committees, and as a result this devoted interest to a common cause cannot fail to present a unified front. Such a consummation is particularly valuable in our country, where, as you doubtless all know, we have carried specialization very far.

Such co-operation as here indicated, however, is not confined to the industry, for we have endeavoured, and we think with quite some success, to prosecute this study in fields which at first thought might appear to be not very closely related to ours. Examples of this are our activities in connection with dealers and plumbers, who frequently sell and install gas burning equipment, particularly water heaters and ranges; the Federal Government groups, such as the Bureau of Mines, Bureau of Standards, Public Health Service, and the like; manufacturers' representatives and other interested bodies which co-operate with the industry in preparation of the numerous specifications with which all appliances submitted to our Laboratory for test must comply.

Five-Year Programme.

There is nothing haphazard about the Association's activities. In general, the Association has followed a Five-Year Programme, set up in 1926, by a Committee of the industry's foremost men, headed by Hon. George B. Cortelyou, approved by the Executive Board and accepted unreservedly by the industry.

This Five-Year Programme, just closing by expiration, will, because of its success, be supplemented by another schedule of organized activities of similar purpose and scope. Briefly, it provides for co-operation within and without the industry, for improved selling methods, stimulation of selling efforts, a greater understanding and appreciation of gas service; it provides for educational campaigns, proper rate structures and their application, and for technical research; it invites attention to the

subjects of asphyxiation and resuscitation; it enlists support of the Testing Laboratory; it advocates campaigns of advertising in trade journals; it solicits attention to national advertising; it supports courses in gas engineering, fellowships in educational institutions, and recommends that statistical work be kept responsive to the needs of the industry.

Its *credo* is:

> " That there be continued adherence to the policy that the Association shall not extend its work beyond those objects which are of first importance and greatest practical value to the industry, it being obvious that if its activities become broadened beyond the scope of practical accomplishment, its influence will inevitably be weakened."

The success of this method of planning and charting a course, endorsed by the leaders of the gas industry in America, is evidenced by the fact that we are now about to enter the second of these " term-plan " programmes following in general aspect the plan adopted in 1926.

Your technicians have contributed much to the progress the industry has made in production methods, particularly with regard to the highly successful research work in the fundamentals of production at both high and low temperatures; also in connection with the application of mechanical equipment to the operation of carburetted water gas units and the dehydration of gas for distribution, to say nothing of the splendid utilization research work which you have accomplished.

Another outstanding and continuing achievement is the progress made in combatting the ever-present problem of smoke abatement as a result of the devoted attention given to this subject by the gas industry over here, in the interests of the health and happiness of your nations. It is a problem that we, too, are facing in the United States in many of our larger cities, and the results of your research, and the literature you have prepared, are of great help to us. The mere listing of the foregoing, which automatically conjures up a long and imposing list, is sufficient; it, therefore, ill behoves me to deal with these things with which you are so thoroughly familiar. Rather shall I endeavour to touch upon some of those features of the gas industry in America which may, for geographical and economic reasons, be of interest to you in that they differ somewhat from the old-established order of things.

In the United States the gas industry has shown a consistent and steady growth, and at the present time serves 16,000,000 customers, 10,700,000 with manufactured gas and 5,300,000 with natural gas. During the year 1930 the industry sold 408,000,000,000 c.ft. of manufactured gas with heating value approximately 540 B.Th.U. per cubic foot, and over 1,940,000,000,000 c.ft. of natural gas with heating value of over 1000 B.Th.U. per cubic foot. The total volume of gas sold was 2,348,000,000,000 c.ft., equivalent to 22,000,000,000 therms; for this the industry received $873,000,000 (£180,000,000). At the present time the total amount of money invested in the gas industry in the United States is slightly over $5,000,000,000 (£1,000,000,000).

A comparison of the industry in 1920 and 1930 shows the remarkable progress made in the last decade. During this period the industry added over 4,600,000 customers, an increase of 40 per cent. Sales of gas increased 110 per cent., and the revenues of the industry increased 61 per cent. Part of this growth is due to additional customers, but a large portion of the increase is due to the intensive development of existing markets. This is indicated by the fact that during the decade the sale of manufactured gas to industries has increased from 69,000,000,000 c.ft. to 163,000,000,000 c.ft., a gain of 135 per cent. In the year 1930, the manufactured gas industry sold over 25,000,000,000 c.ft. of gas for house heating purposes; in 1920 the sale of gas for this purpose was negligible.

The manufactured gas industry in the Dominion of Canada is as much a part of the American Gas Association as is the gas industry in the United States. According to the latest available figures, those for 1929, the manufactured gas companies of Canada at the end of that year served 530,000 customers, an increase of 6 per cent. during the year. The investment dedicated to these patrons aggregated more than $65,000,000, and more than 18,000,000,000 c.ft. of gas were manufactured during 1929, representing an increase of nearly 15 per cent. over the preceding year. Mr. Arthur Hewitt, Vice-President and General Manager of the Consumers' Gas Company of Toronto, Canada, who is well known to most, if not all, of you, is a Vice-President of the American Gas Association.

During the last ten years some interesting developments have occurred in the methods by which the manufactured gas industry produces its gas supply. For many years carburetted water gas has been the foundation of the industry, and in 1920 water gas comprised 60 per cent. of all the gas distributed by manufactured gas companies. Although the production of water gas continued to increase each year, its relative importance declined, so that in 1926 it represented only 51 per cent. of the total gas distributed by manufactured gas companies.

Since 1926 the actual volume of water gas has shown a consistent decline each year until in 1930 this kind of gas represented only 37 per cent. of the total manufactured gas supply. This decline in water gas production has been due to the rapid increase in the use of coke oven gas, either produced in plants owned by gas companies or purchased from steel, chemical, or coke companies. In 1920 coke oven gas represented only 10 per cent. of the total manufactured gas supply, while in 1930 it comprised 30 per cent. During the ten-year period the total volume of coke oven gas distributed increased 382 per cent.

During the last decade the developments in the field of gas production have changed the fundamental character of the industry. In 1920, 86 per cent. of the total gas distributed by manufactured gas companies was produced in their own plants. In 1930 only 57 per cent. of the gas distributed by these companies was produced in their own plants and 43 per cent. was purchased from sources outside the gas industry, such as steel, coke, chemical, and oil companies. In the past two years the amount of gas produced in gas company plants has decreased more than 9 per cent., while the amount of gas purchased by gas companies from outside sources has increased 43 per cent.

During the period from 1920 to 1930 there has developed a rapid trend toward the interconnection of the mains of various companies and concentration of gas production in large, efficient plants equipped with modern machinery. This development has resulted in the scrapping of many gas plants in small communities, which are now supplied with gas through high-pressure gas lines from plants in large cities. This trend towards centralization is indicated by the fact that in 1919 there were 1300 gas plants in operation in the United States, while ten years later there were only 715, a decrease of 585 plants, or 45 per cent.

Natural Gas.

What is undoubtedly the outstanding feature which has affected the manufactured gas industry in the United States more recently, has been development of the newly discovered natural gas reserves, and to a very large degree, the vision and financial backing which made possible long-distance transportation.

Less than a decade ago eminent geologists predicted that the oil and gas supply of the United States would soon be exhausted. These predictions have led to greatly increased activities in search for oil, which in turn have resulted in the discoveries of many new fields containing enormous quantities of oil and gas.

A few years ago natural gas main lines seldom exceeded 100 miles in length and 14 in. in diameter, but the distance of transmission and the size of pipelines has progressively increased until now the largest lines are 1000 miles in length and 26 in. in diameter. The pressure under which the gas is transmitted in these pipelines has also increased; until 1926, 350 lbs. was considered a very high pressure on natural gas pipelines; now there are lines operated at 500 lbs., and some under contemplation which will operate at 700 lbs. pressure.

At the present time natural gas is the only kind of gas used in six States, and it constitutes over 90 per cent.

of the total gas consumed in ten additional States; it is marketed in 36 of the 48 States.

The largest new market for natural gas has been in the cities formerly served with manufactured gas. In some of these communities natural gas has completely replaced manufactured gas, while in other places it has been mixed with water or coal gas to produce a mixture the thermal content of which lies between 600 and 1000 B.Th.U. per cubic foot. There have also been the communities immediately along, or adjacent to, the new natural gas lines *en route* to the larger centres of habitation. By means of these extensions this fuel has been made available in localities which probably might never otherwise have been served.

In the past five years natural gas has replaced manufactured gas in nearly 100 cities and towns, ranging in population from 5,000 to 640,000, and over 1,400,000 gas customers have been affected. Such changes create important economic problems.

At the end of the year 1930 the natural gas industry was serving 5,300,000 customers, indicating that natural gas is used in the homes of 23,000,000 people. In the year 1930 the amount of natural gas consumed in the United States reached the record figure of 1,940,000,000,000 c.ft., for which consumers paid $415,000,000. Of the total natural gas consumed in the United States, domestic or residential consumers use only 19 per cent.; 37 per cent. is used in drilling oil and gas wells and in other oil field operations, 5 per cent. as fuel in petroleum refineries, 14 per cent. in the production of carbon black which is so essential to the rubber tyre and printing ink industries, 6 per cent. in the production of electric power in central station public utility plants, and 19 per cent. by other classes of industrial customers.

There are no complete data available on the gas resources of the country, but in past years estimates of gas reserves have been made in several gas producing areas, and in practically all cases these estimates have been revised upward as time went on because additional drilling of wells, especially those carried to depths of 5000 to 7000 ft., have produced gas which was previously undiscovered. In addition, there are potential gas fields in many States where little or no drilling has been attempted. New oil and gas resources are constantly being discovered which assure the natural gas industry of sufficient supply to meet the demands of the potential market.

In the light of this necessarily brief description of the natural gas side of our industry it will be readily perceived that the effects of the introduction of this potentially enormous volume of 1000 B.Th.U. gas must have been far-reaching. So it has proved; and to-day there is probably no part of the gas industry which is not affected directly or indirectly by its advent. For example, the change-over from previously distributed manufactured gas to natural gas, as a substitute, or as an auxiliary supply for mixing with a manufactured gas, has presented innumerable problems to our Technical Section. An example of this is seen in the study of all joints, and particularly the older types, with a view to repairing them for modern conditions of higher pressure as well as the introduction of a drier gas.

Distribution.

The physical characteristics of natural gas have increased the work and the scope of the Pipe Joints Committee, so that it now is expending considerable effort on the testing of mechanical joints, leak clamps, and various types of couplings, and all types of welded joints to determine their strength and shock qualities. The use of steel pipe has also made it necessary to determine the corrosive characteristics of various soils throughout the country with the thought that suitable pipe coverings can be specified for their protection. This work is being carried on in conjunction with the U.S. Bureau of Standards from the standpoint of determining the type and quality of protection required for any given soil in the United States. Some thought has also been given to main vibration, particularly with reference to mains in metropolitan districts.

The Mixed Gas Research Committee has been concerned with mixtures of various gases available primarily to determine what mixtures are advisable to use under certain conditions, particularly relating to utilization. This work is carried on entirely through American Gas Association laboratory research, and covers a very wide range of gases, including the more common hydrocarbon gases which are available in the United States.

The Water Gas Committee is studying the modification of plant operations to accommodate various gas mixtures from the standpoint of utilizing present plant equipment to accommodate mixtures of natural gas and still gases which are available in many sections of the country.

The Distribution and Chemical Committee are endeavouring to determine the effect of increased quantities of natural gas on distribution systems from the standpoint of leak detection and odorization together with all data that can be compiled on oil fogging, rehydration, and the effect of a drier gas on meters and meter diaphragms.

Butane and Propane.

There has been another very interesting development in the United States which we have watched grow, almost over-night, from a business supplying a relatively small and rather circumscribed demand to one of potentially large magnitude. Its applications are manifold, and in many instances only restricted by transportation costs. I refer to higher members of the series of organic chemical compounds known as saturated hydrocarbons, such as propane and butane, which are easily liquefied and just as easily gasified. By separating them from the natural gasoline extracted from natural gas, new fuels have become available.

Propane, which boils at the lower temperature, is so readily gasified, and requires so little heat for vaporizing it, that it is an ideal fuel for domestic gas installations beyond the reach of gas mains; it is distributed in steel bottles containing from 60 lbs. to 100 lbs. of liquid (21,600 B.Th.U. per lb.). By the use of a suitable pressure regulating valve, it can be burned in ordinary gas burners, bringing gas service to thousands of homes where otherwise gas would be out of the question.

Butane boils at a somewhat higher temperature than propane, and is similar to it, but is not so well suited for domestic installations; it has brought gas to small communities ranging from a few hundred to 5000 population by means of butane-air-dilution plants. Seventeen per cent. of butane vapour is mixed with 83 per cent. of air, and this mixture, because of the low partial pressure of the butane in it, will behave as a permanent gas.

The development of the liquefied petroleum gases is so new that no predictions can be made now as to the position they may eventually occupy in the gas industry.

Research.

Closely allied to the ever-recurring problems of production and distribution of both manufactured and natural gas are the essential bases, in fact the very fundamentals, which can be developed only by research, and so the American Gas Association created a research organization to study the technical problems of the industry and to investigate and pursue research in those subjects that need investigation and development. The field covered includes production of both natural and manufactured gas, transmission and distribution, and the various technical and competitive phases of utilization.

The research activities are under the general supervision and direction of competent Committees headed by the Committee on Co-ordination of Scientific and Marketing Research. Certain research work is also carried on directly by the Testing Laboratory in connection with the preparation of Approval Requirements for various classes of domestic gas appliances.

There are many problems that confront the engineers and salesmen of the industry which, because of their nature or magnitude, would not otherwise be attempted for many years to come, unless some organized body with a national outlook vigorously attacked them.

The work is not all carried on in any one place nor is it confined to any one agency or class of agencies. Fourteen (14) institutions are now prosecuting research under A. G. A. direction; six (6) universities, two (2) United States Government Bureaus, and the private laboratories of six (6) industrial concerns, all financed from the general funds of the Association except the projects in

industrial gas utilization. These projects are supported from a special fund underwritten for a five (5) year period by a group of about seventy-five (75) of the larger gas companies. Some typical projects are studies of pipe coating and corrosion, pipe joints, pipe capacities, mixed gases, and the open flow capacity of natural gas wells.

Probably the most important group of research projects yet undertaken by the Association has been the research in industrial gas utilization. There are twenty-two (22) of these projects, seven (7) having been completed. They cover fundamental research in the application of heat to core baking, bread baking, ceramics, forging, annealing, brass melting, enamelling, galvanizing, house cooling, &c. In addition, original work has been done in decarburization of steel, burning gas with preheated air, reducing burner noises, determining combustion space sizes, &c.

Testing Laboratory.

Domestic utilization is still the backbone of the industry and an important factor in the improvement of utilization processes during recent years has been the appliance testing and research Laboratory operated by the Association. This institution was established and began operations in 1925, and since that time marked improvement in the performance of domestic gas burning appliances has been accomplished.

The Laboratory tests domestic gas appliances for their ability to meet certain basic requirements for safety in performance and such constructional details as are essential to safe and satisfactory performance. The test standards employed are national in their scope and are prepared with the assistance of interested governmental and trade association agencies. To date, some 16,500 different models have met these requirements. Such types are identified by the Laboratory's Seal of Approval. It is estimated that more than 75 per cent. of all the domestic gas appliances sold or offered for sale in the United States during 1930 bore this Seal of Approval.

Aside from a growing acceptance on the part of the public of the use of certified types of equipment, quite a number of municipalities have adopted ordinances requiring in effect that all domestic gas appliances sold, installed, or offered for sale within their limits must meet the requirements of the American Gas Association.

Maintenance of the quality of approved appliances is assured by a system of annual inspections, and each year the Association's inspectors travel approximately 40,000 miles visiting some 250 manufacturing plants now producing approved appliances.

Quite recently the Laboratory extended its investigational activities into the industrial gas field. Complete studies of the process of recuperation and of the possibilities of eliminating objectionable noises during industrial burner operation are now being made.

Utilization.

In the domestic and commercial utilization of gas the important fields are water heating, refrigeration, central house and space heating.

In America the *per capita* consumption of water, particularly hot water, is very high; an estimate for hot water is about 50 gallons of hot water per day per family, and nearly all homes are equipped with hot and cold water supply piping. An interesting type of appliance from the point of view of the small home is the continuous burning gas water heater, which burns from 3 to 5 c.ft. of gas per hour—just about enough to offset the radiation loss from the storage tank, and at the same time to build up about 35 to 50 gallons of hot water per day.

The gas refrigerator has seen very active development, particularly for apartment house use, where it possesses important advantages in quietness of operation, freedom from interference with radio, and the promise of long, trouble-free life since it has no moving parts.

Our homes being generally equipped with central heating systems, house heating by gas has been remarkably rapid. We have a very considerable number of towns in which natural gas of 1000 B.Th.U. per cubic foot is available at rates for the most part lower, on a cubic foot basis, than manufactured gas. With such advantages, gas becomes competitive with coal and oil as domestic house heating fuels, even on a dollar and cents basis and disregarding the many advantages of comfort, cleanliness, and convenience which gas possesses over other fuels. In the manufactured gas field central house heating has also shown increasing growth. Practically every gas company has special rates designed to secure the house heating business. Such rates are, in part, based on the competitive fuel situation, although they are not designed to bring manufactured gas and coal to a basis of dollar and cents equality.

In the commercial field, the American gas industry has borrowed an earlier development of the English gas industry—namely, the diaphragm type of gas burner. For the hotel broiler, in which high speed, high grade results, and low operating cost are the results desired, the diaphragm burner has proven its worth. This is a modification and improvement on the earliest form of surface combustion, developed by Prof. W. A. Bone.

Another important commercial load being developed at present is the so-called large volume water heating business. Because of the fact that our apartment houses have a central hot water supply system, and for the purpose of filling in the summer valleys on the gas sales curves, it has become the policy of many companies to offer gas for large volume summer water heating at prices just a little over holder cost. As a result, we have added the business of apartment houses and hotels, in which the daily hot water consumption runs well over 20,000 gallons.

Another appliance, new within the last year, and which has opened a field hitherto more or less closed to gas, because of price comparison, is the gas unit heater. This type of heater consists of a bank of tubes heated by gas, and over which a large volume of air is blown by an electric fan attached to the back of the unit. This heater, having an output capacity of 100,000 B.Th.U. per hour in the smallest sizes, eliminates the need for boiler plant and for steam piping; it is only necessary to run a gas line, and supply the electric power from the nearest outlet.

Commercial.

The commercial activities of our gas companies are tied in to close co-operation through the active participation of the responsible heads of various commercial departments in the programme of the Association. Particularly in commercial fields have the many Committee activities been found of greatest value, as they crystallize national opinion into more or less uniform modes of procedure.

To illustrate: House heating, for example, in 1922 was an activity of only a very few gas companies, and special rates for house heating were almost unknown. A National Committee was formed, and its first efforts were to gather the technical data underlying house heating requirements. Following this, gas company interest grew rapidly, and the business began to expand, until to-day there are literally hundreds of companies actively engaged in selling gas for house heating through the adoption of special house heating rates. Again, in 1929, the need was felt for a more uniform policy in regard to sales and servicing of these appliances, and a strong Committee, comprising men right on the firing line in the house heating business, made it possible to carry through an ambitious project with great effectiveness.

Other Committees exist for promoting the use of domestic ranges, water heating, incineration, laundry equipment, refrigeration, appliance servicing, trade and dealer co-operation, architects' and builders' service, window and store display. Because the high cost of appliances is a deterrent to the development of the business, the Commercial Section has initiated an activity with the Manufacturers' Section, looking to the simplification of gas range design and reduction in number of models manufactured, so that, first, the cost of manufacturing gas ranges may be reduced, and, second, the number of models and parts required to be carried in stock by the gas companies may be reduced.

The statistics of gas consumption in the United States indicate that families using only a gas range burn about 2000 c.ft. of gas per month. Since such families do not enjoy to full advantage the services which the gas indus-

try can render in water heating, incineration, and refrigeration, the Commercial Departments have devoted considerable time to studies of how this load can be built up.

The public is getting away from poor appliances, and is realizing what the gas industry is offering through its plan of proving gas appliances to be modern merchandise. When gas appliances were of a bargain counter nature, and the merchant interested himself only in merchandising turnover and lost interest in the delivery of the appliance, complaints were frequent, and were usually based on poor gas or poor service. These things we have been trying to offset with our goodwill and public relations efforts.

In this particular phase of our commercial activities and its necessary publicity and advertising, I should like to take this opportunity to compliment the British gas industry upon the outstanding work undertaken by the British Commercial Gas Association. We are close students and ardent admirers of this work, to say nothing of the respect and admiration we, in the United States, have for your distinguished leader, Sir Francis Goodenough.

Publicity and Advertising.

In the manner and method of sales of our product, particularly in publicity and advertising, our Publicity and Advertising Committee renders direct services to company members by supplying suggestive advertising material, which is published in local newspapers, sometimes as originally written and sometimes altered to meet local conditions.

Just now our Advertising Committees are deeply interested in working out a programme looking toward the inauguration of a radio campaign. A quarter or half an hour on fifty or more broadcasting stations, about the minimum which could adequately reach people in the States, is an expensive gesture, and before the Association enters upon this form of telling the world about gas in a national way, the matter will be submitted to our membership to see if the cost involved would be justified.

Generally speaking, our Publicity and Advertising Committees have charge of the preparation of all classes of publicity and advertising service issued for the industry, and, in addition, have advisory duties in connection with the American Gas Association Monthly, which is our organization's official publication. The A. G. A. Monthly's principal object is to reflect Association activities. It has a circulation of 6675 copies.

Industrial.

With regard to utilization for other than domestic purposes, rather than manufacturers and sellers of gas, we have now become merchandisers of heat service. Our markets are in every field where the application of heat is a requirement. Every modern industry is an actual or potential customer for our product. Also, they are potential customers for merchandisers of other forms of heat.

Our Industrial Gas Committees have planned their efforts along two distinct paths; first, the education of gas company personnel in the technical phases of the utilization of gas and in the higher development of sales ability; second, to create attention among our potential users for recognition of our fuel as the ideal.

To accomplish the first we have Committees, such as the Utilization Data Committee, gathering and publishing data on all possible uses for gas, and specific Committees gathering information and recommending policies on the use of gas in the hotel and restaurant field and in the large volume water heating field. Also, the Section publishes pamphlets and books for distribution and sale to our industrial men, known as the Industrial Gas Series, each volume of which is a complete treatise on a particular subject.

The second part of this programme is accomplished through Committees such as our Advertising Committee, which advertises in a number of trade journals of specific industries, and our Publicity Committee, which furnishes articles for publication in such trade journals.

Under the direction of the Industrial Gas Section a national campaign on industrial advertising was inaugurated some five years ago. This advertising programme includes purchase of advertising space in trade journals and engineering college publications. The Committee in charge makes every effort to induce the local gas companies to co-operate with the national campaign through suitable advertising in their local newspapers and other media.

National Exhibitions.

Exhibitions of industrial gas burning equipment in which our Industrial Gas Section co-operates with the gas companies and manufacturers are held in connection with the annual meetings of the Steel Treaters' Association; Ceramic Society; National Exposition of Power and Mechanical Engineering; International Bakery Equipment Exposition; and Heating and Ventilating; a policy we hope to expand.

Our Manufacturers' Section performs, in addition, a most useful and valuable function in that every year at our Annual Convention they arrange an exhibit of all of the latest developments in production and utilization equipment, as well as all the necessary appurtenances to an industry with so many and varied angles. In 1919 some 9,000 sq. ft. of space were required by 100 exhibitors, whereas at our recent Convention (1930) 253 exhibitors required 75,000 sq. ft.

Rates.

Now, the all-important question of rates and rate making. From the ancient monthly charge applicable to gas lighting, now a matter of history, the development of gas cooking brought about a flat charge of so much per 1000 c.ft. regardless of the amount used. As domestic uses grew in number, with varying demands, and when gas entered the industrial and house heating fields, it became necessary to make such rates as would command large volume business by suitable reductions of the consumption charge for large volumes. Out of this grew the service charge, the initial charge, and the minimum monthly charge on domestic business, and the demand charge on industrial and house heating business, so favourable to the development of the industry, and so just to the consumer by charging against each customer relatively what it costs to serve him. This theory is now in general practice in the United States, and has been recognized by innumerable commissions and court decisions. Efforts to bring this about have resulted numerically in a multitude of rate forms, and some company schedules contain as high as ten different rates for different classes of service.

Last year witnessed the birth in America of the thermal basis of billing customers. This was done in August, 1930, by the second largest gas company in America, the People's Gas Light and Coke Company of Chicago. At the present time nine of the larger companies, serving 25 cities and towns in various sections of the country, have adopted this therm method of billing, and the future promises an even more widespread use of the method of billing with which you are all so familiar.

An important factor in the adoption of this method of billing is the expansion and development of the natural gas phase of our industry. In former years the average American gas company was a compact self-contained local affair, and the thermal content of its product was adjusted to suit local conditions, and remained relatively stable for years, but to-day in many sections of the country our companies are really a vast interconnected pool of gaseous energy. Some companies now serve gas consisting of a mixture of Bye-Product Coke Oven Gas, Water Gas, Oil Still or Refinery Gas, as well as Natural Gas, and the physical and economic modifications of all these factors present complicated problems which may necessitate variations in the thermal content of the gas marketed.

Statistical studies of all the rates in effect in the territories served by companies supplying gas in the United States are shown in Tables 1 and 2, and the comparison for the five-year period, Jan. 1, 1925, to Jan. 1, 1930, indicates that there is a definite trend toward—

(1) The use of more rates—*i.e.*, different rates for different classes of service.

(2) The recognition of the service cost element in domestic rates, either through a service charge or a relatively high initial charge for the first few hundred cubic feet.

(3) The establishment of the demand principle in industrial and house heating rates, through the use of demand charges or rates of the Wright Demand type.

1. The use of more rates. Between 1925 and 1930 the number of rates other than general rates increased sixfold (from 169 to 1038).

2. The recognition of the cost element in domestic or residence rates. When house heating is excluded we find that the cost of supplying other domestic service consists largely of customer cost which is alike or almost alike for all customers. The demand cost is not important until house heating is considered, and it is only natural that we find the general domestic rates changing gradually to rates which either have a direct service charge or which carry an element of service cost in the charge for the first few hundred cubic feet. There have been numerous pertinent decisions from the regulatory bodies (Public Service Commissions) and the Courts which indicate a growing recognition of the fundamental requirements of the gas industry with reference to rates and rate making. Such decisions have definitely approved, as being best for the customer, the service charge, the minimum bill, or that form of rate in which is incorporated some of the elements of the cost of service in the charge for the first few hundred cubic feet.

It is necessary to keep in mind that if service cost element in the rate is too large, the commodity charge will be lowered to such an extent that considerable peak load space heating may result. If the service cost element is small, the resulting commodity charge may be so high that the company may not be able to obtain much additional load from water heaters and other smaller appliances.

3. The establishment of the demand principle in industrial and house heating rates. In supplying house heating service, the volume per customer is very large, and the diversity factor practically disappears owing to everyone turning on his maximum requirements during extremely cold weather. Thus a demand charge becomes more important. Most of the house heating rates now in effect contain demand charges based on the square feet of radiation in the home. In industrial service a demand charge which permits the customers with high load factors to earn a lower average price, enables the gas company to meet competition better.

In nearly, if not quite, every State of my country a Public Service Commission or Board has been created to administer the public service regulatory laws of the State. These Commissions mostly have broad jurisdiction over rates, service, the issuance of securities, &c., and in many States no new utility may begin business without first securing the Commission's approval. The orders and decisions of these Commissions, however, are subject to review by the Courts of the respective States, as well as by the Federal Courts of the United States up to and including the Court of last resort, the Supreme Court of the United States.

The principal question which brings such matters into the United States Courts is violation of that Section of the Federation Constitution of the United States prohibiting confiscation of property. This section has been held to forbid the enforcement by regulatory bodies of rates which are not sufficient to enable a public utility company to realize a fair return upon the value of the property.

As a result of the work of our Rate and similar Committees in other branches of the public utility industry, there has developed a great sense of unity, common interest, and co-operation between the different groups of public service enterprises in the handling of valuation and other basic rate questions. Rules and principles of valuation judicially determined in railroad or telephone cases frequently become the controlling precedents in gas and electric cases, and *vice versa*.

Marked progress along these indicated lines has been made to such an extent that the fundamental principles which must control regulatory rate administration and service are gradually being placed outside the field of controversy by successive judicial decisions, which necessarily become the guide marks for administration by the State Commissions. The subject of rates and rate making is to-day being more thoroughly and courageously studied by company executives, counsel, and public officers; and phases that were long left obscured and neglected are far better understood than formerly, with the aid of continuous clarification from the Courts and some of the Commissions.

The subject of the legal basis of rates, though constantly receiving clarification, is a living and ever-developing one, and hence can never become completely stabilized. New problems, particularly those presented by the present rapid development of natural gas supply on an enormous scale, call for the enunciation of new legal principles for rate making or new applications of old principles.

Further reference to the statistical tables previously mentioned also illustrates the growing use of promotional rate structures in the general service and domestic field.

Five years ago only 25 per cent. of the domestic rates could be termed promotional or in any way based on sound theories of rate making practice, but to-day nearly 50 per cent., or one-half, of domestic rates embody some of the elements of fixed cost; this 50 per cent. probably representing 80 per cent. of the entire gas sold.

In addition to this marked increase in the number of domestic rates reflecting the element of fixed cost, there have also been significant changes in the provisions regarding minimum bill. Five years ago nearly 10 per cent. of the domestic rates had no minimum bill provision—that is, if the customer used no gas he received no charge from the company. However, to-day nearly 93 per cent. of the domestic rates for gas service in America contain some sort of minimum bill provision.

While as yet there are relatively few of the three-part demand rates applying to domestic service, the use of these demand rates reflecting the various elements of cost has shown a marked increase during this period. This is especially true of the rates for heating homes and dwellings with gas, as the number of demand rates for this type of service increased from 7 at the beginning of the period to 164 at present.

The extent to which rates for special classes of service have increased during the period is also noteworthy. For example, five years ago the total number of house heating rates was only 40, whereas to-day there are more than ten times that number.

The same general tendencies are apparent for rates applicable to other special classes of service, such as industrial and commercial uses, water heating, and other rates designed to secure special classes of business.

Statistics.

The information on which these tables are based, and, in fact, all the financial and operating data published by the American Gas Association, are secured through its Statistical Department, the activities of which may be considered under two general phases. There is, first, the gathering and collection annually of the general statistics on the industry, such as plant capacity and data on production, sales, customers, and bye-products, together with a detailed income statement and balance-sheet. Most of the data outlined above are published in bulletins issued from time to time by the Association.

In addition to such annual data, there is also collected monthly data on production, sales, and revenues from companies representing about 80 per cent. of the manufactured and natural gas sold. The publication of these current monthly data on operating and financial movements within the industry, in daily general and financial newspapers has been of great value, not alone to the industry itself, but to the financial and investment community.

The collection of statistics on the gas industry is somewhat complicated by the interrelations of this industry on the one hand with the coke and steel industries through the purchase from these industries of bye-product coke

TABLE 1.—*Comparison of Manufactured Gas Rates in Effect on January 1, 1925, and January 1, 1930.*

Classification of Rates according to Class of Service and Type of Rate Schedule.

MANUFACTURED GAS INDUSTRY IN THE UNITED STATES.

Rate Type No.	Type of Rate.	CLASSES OF SERVICE.																							
		Class 1. General Service or Domestic Rates.		Class 2. House Heating Rates.		Class 3. Industrial Rates.		Class 4. Commercial Rates.		Class 5. Industrial and Commercial (Wholesale) Rates.		Class 6. Water Heating Rates.		Class 7. Commercial or Building Heating Rates.		Class 8. House Heating and Industrial Rates.		Class 9. Off Peak Industrial and Commercial Rates.		Class 10. Special Domestic Rates Available Only to Customers Using Gas-Fired Water Heaters.		Class 11. Miscellaneous Rates.		Total Number of Schedules for all Classes of Service.	
		1925.	1930.	1925.	1930.	1925.	1930.	1925.	1930.	1925.	1930.	1925.	1930.	1925.	1930.	1925.	1930.	1925.	1930.	1925.	1930	1925.	1930.	1925.	1930.
1	Straight line rate . .	231	125	7	133	12	4	5	6	1	6	1	8	0	1	1	1	0	1	0	0	0	0	258	285
2	Step rate	14	12	0	0	3	6	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	17	21
3	Block rate	459	473	6	51	46	72	4	10	0	20	1	7	0	11	0	1	0	2	0	19	0	5†	516	671
4	Block rate with small initial block constituting minimum bill and remainder of schedule of straight line form .	11	23	2	15	0	2	0	0	0	3	0	1	0	4	0	0	0	0	0	6	0	0	13	54
5	Block rate with small initial block constituting minimum bill and remainder of schedule of block form . . .	134	300	12	26	2	13	1	12	0	15	0	6	0	1	1	5	0	2	0	14	0	0	150	394
6	Service charge *plus* gas at straight line rate .	36	41	0	14	5	1	0	0	0	0	0	2	0	1	0	0	0	2	0	1	0	0	41	62
7	Service charge *plus* gas at block rate . . .	61	74	1	20	8	14	0	1	0	5	0	9	0	1	0	1	0	0	0	12	0	0	70	137
8	Service charge *plus* gas at step rate . . .	3	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3
9	Two part demand rate	3	18	3	125	17	73	0	16	4	49	0	7	0	15	0	4	0	2	0	2	0	0	27	311
10	Three part demand rate	1	14	4	39	10	23	0	3	5	17	0	0	0	0	1	4	0	1	0	0	0	0	21	101
11	Wright demand rate .	0	3	5	17	0	21	0	2	1	0	0	13	0	1	0	0	0	0	0	22	0	0	6	79
	Flat rate	0	0	0	0	0	0	0	0	0	0	0	2*	0	0	0	0	0	0	0	0	0	1‡	0	3
	Miscellaneous rates .	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Grand total . .	953	1084	40	440	103	231	10	51	11	118	2	55	0	35	3	16	0	10	0	76	0	6	1122	2122

* Flat rates based on demand. † Garage heater rates. ‡ Flat monthly charge for gas refrigerator

TABLE 2.—*Comparison of Manufactured Gas Rates in Effect on January 1, 1925, and January 1, 1930.*

Percentage Distribution of Rates for each Class of Service according to Type of Rate Schedule.

(This Table is based on Data shown in Table 1.)

Rate Type No.	Type of Rate.	CLASSES OF SERVICE.																							
		Class 1. General Service or Domestic Rates.		Class 2. House Heating Rates.		Class 3. Industrial Rates.		Class 4. Commercial Rates.		Class 5. Industrial and Commercial (Wholesale) Rates.		Class 6. Water Heating Rates.		Class 7. Commercial or Building Heating Rates.		Class 8. House Heating and Industrial Rates.		Class 9. Off Peak Industrial and Commercial Rates.		Class 10. Special Domestic Rates Available Only to Customers Using Gas-Fired Water Heaters.		Class 11. Miscellaneous Rates.		Total Number of Schedules for all Classes of Service.	
		1925.	1930.	1925.	1930.	1925.	1930.	1925.	1930.	1925.	1930.	1925.	1930.	1925.	1930.	1925.	1930.	1925.	1930.	1925.	1930.	1925.	1930.	1925.	1930.
1	Straight line rate . .	24·2	11·5	17·5	30·2	11·6	1·7	50·0	11·7	9·1	5·1	50·0	14·5		2·8	33·3	6·3		10·0		0·0		0·0	23·0	13·4
2	Step rate	1·5	1·1	0·0	0·0	2·9	2·6	0·0	2·0	0·0	1·7	0·0	0·0		0·0	0·0	0·0		0·0		0·0		0·0	1·5	1·0
3	Block rate	48·2	43·6	15·0	11·6	44·7	31·2	40·0	19·6	0·0	17·0	50·0	12·7		31·4	0·0	6·3		20·0		25·0		83·3	46·0	31·7
4	Block rate with small initial block constituting minimum bill and remainder of schedule of straight line form .	1·1	2·1	5·0	3·4	0·0	0·9	0·0	0·0	0·0	2·5	0·0	1·8		11·4	0·0	0·0		0·0		7·9		0·0	1·2	2·5
5	Block rate with small initial block constituting minimum bill and remainder of schedule of block form . . .	14·1	27·8	30·0	5·9	1·9	5·6	10·0	23·5	0·0	12·7	0·0	10·9	No schedules in 1925	2·9	33·3	31·1	No schedules in 1925	20·0	No schedules in 1925	18·4	No schedules in 1925	0·0	13·3	18·6
6	Service charge *plus* gas at straight line rate .	3·8	3·8	0·0	3·2	4·9	0·4	0·0	0·0	0·0	0·0	0·0	3·6		2·9	0·0	0·0		20·0		1·3		0·0	3·7	3·0
7	Service charge *plus* gas at block rate . . .	6·4	6·8	2·5	4·5	7·8	6·0	0·0	2·0	0·0	4·2	0·0	16·4		2·9	0·0	6·3		0·0		15·8		0·0	6·2	6·5
8	Service charge *plus* gas at step rate . . .	0·3	0·1	0·0	0·0	0·0	0·9	0·0	0·0	0·0	0·0	0·0	0·0		0·0	0·0	0·0		0·0		0·0		0·0	0·3	0·1
9	Two part demand rate	0·3	1·6	7·5	28·4	16·5	31·6	0·0	31·4	36·4	41·5	0·0	12·7		42·9	0·0	25·0		20·0		2·6		0·0	2·4	14·7
10	Three part demand rate	0·1	1·3	10·0	8·9	9·7	10·0	0·0	5·9	45·4	14·4	0·0	0·0		0·0	33·4	25·0		10·0		0·0		0·0	1·9	4·7
11	Wright demand rate .	0·0	0·3	12·5	3·9	0·0	9·1	0·0	3·9	9·1	0·0	0·0	23·7		2·8	0·0	0·0		0·0		29·0		0·0	0·5	3·7
	Flat rate	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	3·6		0·0	0·0	0·0		0·0		0·0		16·7	0·0	0·1
	Miscellaneous rates .	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·9	0·0	0·0		0·0	0·0	0·0		0·0		0·0		0·0	0·0	0·0
	Grand total . .	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0		100·0	100·0	100·0		100·0		100·0		100·0	100·0	100·0

oven gas, and on the other with the petroleum industry through the utilization of natural gas.

Accounting.

Closely allied with the collection of statistical information, its interpretation and dissemination is the work of the Accountant, which, it will be noted from my earlier references, is represented by a Section of our Association.

Perhaps the greatest contribution of the Accountant, during the last decade, to the progress of the gas industry in America, is the adoption of mechanical aids to accounting work. It would be difficult to-day to find, even among the smallest of our utilities, one that has not employed, to some extent, the use of machines in accounting work. The customers' ledger of a few years back, a bound, cumbersome book, is rapidly losing favour, and in its place is found a card carrying all the information necessary to the keeping of the customers' accounts. In some instances even the card is displaced, and a stub, which is part of the monthly bill, serves the purpose of the ledger account. In addition to their use in customers' accounting routines, machines are employed in accounting for stores, in the keeping of general ledgers, payrolls and property accounts, and are always employed where their use will economically produce speed and accuracy. Machines are also used by the Accountant for such purposes as sales analysis, as an aid to the rate maker, and as an aid to the salesman, in the tabulation of the results of the merchandising of appliances. Progress has been made in the development of mechanical accounting equipment through the co-operation of the utility accountants with the manufacturers of accounting machinery.

The Accounting Section Committee, in conjunction with Committees representing the other major utilities, and in co-operation with representatives of the several State Commissions secured the adoption, by the States, of a nation-wide uniform classification of accounts, thus enabling, without the loss of time, the preparation of consolidated statements and standards of comparison.

Education.

Educational work is another vital activity, and the Association has always co-operated with the educational institutions in their efforts to offer instruction of particular interest to the gas industry. Lecturers are provided to outline the practical application of the theory taught in the classroom, as to the production, distribution, and utilization of gas. The advice of the Association has been sought and supplied on the conduct of specialized courses intended to train for employment in the industry. There are now gas engineering courses offered under separate departments by two outstanding institutions in the United States—the Johns Hopkins University and Purdue University, both of which are making splendid progress. Other institutions offer courses especially designed to train engineers for the gas industry, although they are not established as separate departments.

In order to stimulate the efforts of the various gas companies to render an outstanding degree of public service in their local communities, a new award has recently been offered to gas company members of the Association; each award is limited to companies falling within a certain size so that their conditions of service may be reasonably similar. The nature of the award is significant in that it comprises three scholarships at one of the Universities offering special courses for public utility executives, it being contemplated that these scholarships will be filled by the three executives in charge of finance, operating, and sales activities so as to bring about a higher degree of co-ordination between these departments.

In an effort to supply specialized instruction to employees of the gas industry, instruction which is generally not available elsewhere, the Association offers courses in Domestic Gas Salesmanship, prepared for gas company employees engaged in the sale of gas appliances to domestic customers; Sales Administration and Management, intended to be used by department heads in perfecting better sales administration and management methods in the domestic, commercial, and industrial gas fields; Industrial Gas Salesmanship, designed to give the salesman a detailed grasp of the uses of gas in industry. In addition, there are home study courses on Manufactured Gas requiring an elementary knowledge of physics and chemistry, and a home study course on Manufacture, Distribution, and Utilization of Gas written in non-technical language. A technical home study course in natural gas is also in preparation. Scholarships in recognized institutions are also awarded.

Since the public is prone to receive its impression of the gas industry from meter readers, collectors, telephone operators, and others whose positions bring them in daily contact with customers, these employees have vast power to create a friendly or hostile atmosphere. Of the various training programmes designed to improve employee performance on the job, none has been so productive of results as the Association's Course in Employee-Customer Relations. The purpose of this programme is to stimulate employees to analyse customer contacts and plan a future procedure so that correct methods of dealing with customers become habitual. There are more than 5,000 contact employees enrolled in this course, and the executives of many gas companies tell us that the course has crystallized employee thinking to an extent never before reached.

Asphyxiation and Resuscitation.

Asphyxiation and Resuscitation are subjects of the continued attention of the Committee responsible for their study, in order to promote the use of safe methods of producing, distributing, and utilizing gas in the home and in the industry. The work comprises collection and interpretation of employee accident statistics; preparation of pamphlets and posters designed for use by gas companies in promoting safe operating methods; award of medals for successful resuscitations accomplished in cases of asphyxiation, such as the McCarter Medal Award made available through the generosity of Mr. Thomas N. McCarter, President of the Public Service Electric and Gas Corporation of New Jersey, to gas company employees for successful application of the Schaefer Prone Pressure method of resuscitation; examination, test, and approval of first aid and safety devices, and other related activities.

During the past three years a Special Commission of the Association, on Asphyxiation and Resuscitation, has sponsored research work by the United States Bureau of Mines designed to ascertain substances suitable for addition to gases distributed by the manufactured and natural gas branches of the industry, which would act as warning agents either by virtue of odours or because of so-called irritant effects. The final report of this investigation will cover all aspects of the use of such agents from the Laboratory and limited field test angle, and it is expected that gas companies generally will subject these substances to the prolonged field test necessary to prove their suitability and effectiveness.

The widespread extension of natural gas service in recent years has brought about a demand for the use of some odorizing agent to signify the presence of this otherwise odourless gas. A number of natural gas companies are already using odorants continuously for this purpose, and others for intermittent tests of distribution systems, house piping, and consumers' appliances to disclose leaks of all kinds.

Conclusion.

In bringing these remarks to a close permit me again to remind you that the American Gas Association, through its President, is deeply conscious of the honour you have done it in asking us to participate in the programme of the First International Gas Conference and the 68th Annual General Meeting of the Institution of Gas Engineers. It has been with no small pleasure that I have attempted to tell you something about the problems of the industry in the United States.

Mr. Paige, in introducing his paper, said: Mr. President, and distinguished friends from all over the world, ladies and gentlemen, the paper which is before you has been prepared as undertaking to set forth the position of the Gas Industry in the United States as we see it. Whatever there may be about it of which you do not approve, you can assign to me. For whatever you may find of value, the credit should be given to Major Forward and his most efficient staff, to whom I am greatly indebted for the pre-

paration of the material. I have expressed in the text of the paper our gratitude and pleasure at being invited to attend this meeting. I cannot convey to you the honour we feel in coming over here and the pleasure it gives us to receive the welcome that we have.

In the early part of the paper there is some review of the history. There are some things which are not mentioned there, but history indicates that the Industry had its inception here in 1812 when William Murdoch first showed the use of gas. In the background of that picture is a more or less Utopian land of promise which he had hoped to accomplish, but it has not worked out exactly as he indicated it might. I have seen in the Gas Light and Coke Company's premises a picture of Murdoch, and across the room from that portrait is a painting of Sir Corbet Woodall, for many years one of the greatest inspirations to the entire Gas Industry in America. We regard all your people here with respect and admiration amounting almost to reverence. Even in the early days we looked to you for instruction and guidance in the development of our business. I remember 28 years ago wanting to read some books on the Industry. I wrote to the then American Gas Association and found that the available books were all English books. We have had a great deal of material published since in America, but in those days we relied on you for all we got. Our own business was not behind yours by very many years, because gas lighting was an accepted thing in Baltimore, Maryland, in 1816, and the Baltimore Company was organized soon after that. It may, however, surprise you to know that natural gas, of which I shall speak briefly a little later, was first used in the United States 104 years ago, which is quite a long time ago, because natural gas became a popular subject for discussion even outside the Gas Industry quite recently.

As my subject indicates, I deal also in the paper with the affairs of the American Gas Association, and I want to point out that, while you have your Associations specializing in their various activities, by reason of our geographical situation and other things we have had to bring our activities together as far as National Associations are concerned and deal with the business of the Industry in sectional and departmental organizations. It must be evident to you what this involves when I tell you that at the last Annual Meeting of the American Gas Association there was a registration of 6300 delegates. Consequently, the sectionalizing of the organization has been made very necessary. We found further that the success of our enterprise in America depends very largely on the co-ordination of effort and the co-operation of all branches of the business. None is independent. We have inter-departmental relations in the Association, and we have them in the companies, and the greatest necessity for us is to develop that relationship so that all work for the good of the whole.

We have branched out somewhat in recent months and years in this theory and idea of co-operation because we have found it very necessary to convert influences in the community which might be hostile to our interests to a state of mind where they become active friends of our business. I refer in this respect to the necessary co-operative effort between all kinds of dealers and plumbers. We have gone into merchandising extensively in the States. In many cases we have gone very far; for example, there appeared in a newspaper advertisement in one of our communities a picture of a gas range, in connection with which it was stated that it might be had in any colour and that the purchaser might have his kitchen decorated to match the colour of the range he purchased. In addition, he would be presented with a 56-piece set of china, a garbage pail, a sweeper, and all utensils necessary for cooking. The result was that all the dealers in that community felt that their business was being taken away from them. Our position in the States is that we are not in the appliance business because we choose to be. We are in the gas business, but in order that the gas business shall have its proper place we find it very necessary for us to develop a receptiveness on the part of our consumers. We have done a great deal along that line, but we have still a great deal more to do. We have no solution, as far as I know, to any problem, because every solution seems to bring with it an amplification of opportunity which, if properly grasped, involves our having to solve two more problems. The development of our Association work is not haphazard. It cannot be. It is too much of an organization, too highly diversified, and its control is definitely centralized, and in order that there shall be no waste of effort we instituted in 1926 what we called a five-year programme, and I think perhaps we may claim the origin of this phrase which has become commercially used recently. It was in 1926 that one of our greatest leaders in America, the Hon. John E. Corbett, President of the Consolidated Gas Company of New York, set forth the ideals of the Association, and had in mind this—that carried away by false enthusiasm we might easily reach a point where we over-developed at certain points to the neglect of certain others. Consequently, in my paper you will find the conditions set forth under which the Committee operated. I must say here that in our situation we are finding every day the necessity for more and more highly developed salesmanship, probably because the agencies of competition to-day are stronger than they ever were; they are more highly organized and more willing to make concessions, and that is particularly the case since November, 1929, when the stock market took what we call a toboggan slide. The manufacture of gas in Canada is as much a part of the American Association as the Gas Industry in the United States, and at this point I want to say that one of my keen regrets is that we do not have with us to-day that wonderful man from Toronto, Mr. Arthur Hewitt. We think so highly of him that he is now a Vice-President of the American Association.

I will not undertake to go into the details of this paper, but in the matter of butane and propane I want to tell you that we find the development of these products from natural gas a great problem. The periodicals are filled with information on this subject. It is difficult, however, to get final and authentic information, one reason being, I think, that no one knows. For example, it was freely predicted that the natural resources in the United States so far as crude oil was concerned would be exhausted in seven years. To-day, however, the market is so "soft" that you can almost buy it at your own price, and we do not know what to do with it. I mention this as indicating that the best men in the country were unable to forecast what would happen. It is true that we have found enormous new resources, but the resources which were appraised as to flowage and capacity have not yet been exhausted. We have that problem to meet. We are told there is enough butane and propane available in the United States to supply the needs of the entire nation. Much of it must find a market, and our problem will be adapting ourselves to the acceptance and assimilation of it, and facing it as a competitive fuel. That is a problem that may be local now, but may not be so local as time goes on, and there you get the point as to preparation for future competition, which is infinitely more important than meeting present competition. In order to anticipate what can be done in that direction, you will find in this paper reference to the activities of the Association in the matter of research. In our country to-day bankers and investors, in calculating the value of property for the purpose of trust investment, are not content to know the earnings of a company over a period of years. They want to know something about management. They want to know the attitude of that company towards research activity. Research means diversity of adaptability to changing conditions. We have had the experience of disturbed conditions in our Gas Industry in the United States, of finding that we go along with reasonable success, and that when other businesses are prosperous we manage to hold our own and survive, but when the disturbed business condition arises—and all business is uncertain—we find the utilities, gas and electricity, stand out like beacon lights on the horizon, stabilizing and regulating things. They help to keep people from becoming thoroughly panicky, and it is well that it should be so not only on account of the investors and their pockets, but because of the communities and their families which represent such a substantial proportion of the population.

I should like to draw your attention to the fact that in the development of our business we have gone extensively into gas refrigeration. I think you will be amused at the number of refrigerators that are being put in. For instance, the Consolidated Gas Company of New York sold 30,000 units last year. It is the fact that the consumption of gas in refrigerators per month is not great, but we have a situation in our urban communities in which we are compelled to concentrate more and more. We are becoming to some extent in our cities a nation of cliff dwellers, people living in small apartments with smaller kitchens. There has been some tendency not to put gas pipes into these new buildings in spite of all we could do through our Association with architects and builders, but if the gas refrigerator did not use any gas at all it would still be a valuable appliance to get installed, because it introduces the gas pipe into the kitchen and makes every tenement and apartment a prospect. More especially it restores the romance of gas, the magic of cold and heat, and that is the thing we need in our country as much as anything—to fire our imagination and freeze our competitor. [Loud laughter.]

That leads me to speak on another subject. We have perhaps the most highly developed competition that history has ever known. We have competition of all sorts, and it is growing. The Gas Industry of the United States—and, I think, of any other country—is not so heavily endowed with a fairy godfather as our brother utility, the

electrical industry. One of the aspects of our effort lies in this. We believe that the more wonderful gas appliances we can get installed and the more quickly we can get them operating, the less we have to fear from the inroads of competition, because, no matter what advertising we may do, the fact remains that appliances are sold by the satisfaction of the consumer as well as by advertising; so much so that we may very well consider that the customer of a gas company is really the employer of the person connected with the company, no matter what capacity he is in. So we have done a great deal in replacing what we call old and obsolete equipment with the very latest, designed, of course, for efficiency and economy as well as attractiveness, to the end that the housewife shall take a pride in showing off her kitchen to the visitor. We accomplish sales by this, but we realize that if we undertake a thing like that we cannot do it 100 p.ct.

We acknowledge, as I have said, very many problems to meet. One of the greatest is that of getting an adequate sale for equipment which heats water. We use a great deal of water in the United States [laughter], but we use water mostly for bathing even now, and we require heat. We want to sell hot water service. We cannot sell gas. Who wants gas for the sake of gas? What people want is comfort and convenience, and we must meet them in those terms. At the moment we find ourselves disappointed in the volume we are getting of the best load business—the business which saves you from building new works and laying down mains which may earn handsomely for one hour out of the twenty-four, and thereafter become a liability. The only way we can get that business, in our idea, is by the development of what we call promotional rates. It is a very difficult problem, because there are very few minds in agreement as to what is ideal. However, a start is being made and, as you will see in this paper, the number of promotional rates operating in the United States has grown in five years from 105 to 1600 or so. It is a tremendous increase, but at the same time we must develop ideas that will get us business. Rates alone will not get business.

Our business does not re-act to hysteria, whether of optimism or depression. We have to develop as we go along. A great deal is being said in the papers about education; you are familiar with it, but the greatest education we can undertake is education in salesmanship, and by that I do not mean for one moment that the engineer has not got the biggest job, because with these competitive influences it is the switchboard costs of electricity you have to meet no matter what happens. Therefore it is both an engineer's and a salesman's job. The electrical people have done a wonderful thing in bringing down their costs. Therefore we must have research in engineering, in production, and in distribution. At the same time we need salesmanship, and a greater toleration and appreciation than we have ever had before. The supreme example of salesmanship in the world to-day is, I think, that of His Royal Highness the Prince of Wales, who is selling the nation—[loud applause]—and let me tell you he *is* selling it. There is no doubt about it. His motto is, " I serve," and we might very well take it to ourselves, because what we can accomplish will be in proportion to our service.

I will not detain you any longer, but I must again say how glad I am to be here, and how pleased we shall be to welcome you if you come to our country.

DISCUSSION.

The PRESIDENT: I hesitate to offer a few halting remarks after the excellent and eloquent speech we have just listened to; but someone has to open the discussion, and I suppose it is my privilege to do so. I should like to thank Mr. Paige particularly for the graceful compliment he has paid the British Gas Industry in the first part of his paper. I should also like to assure him that the British Gas Industry does not rely on its history or its traditions. It is still full of activity and is receptive of all new ideas, and we welcome the very useful ideas from across the Atlantic which Mr. Paige has been good enough to offer to us. I think the organization of the American Gas Industry as set out in the paper is a model organization. I am not at all sure that we in this country have an organization which can compare with it. I refer to our District Associations and our Junior Associations, and I think that if we were to adopt something on the lines which are indicated by Mr. Paige, we might gain some advantage in our gas organizations in this country. I have been very much struck by the extraordinary magnitude of the Gas Industry in America as shown by Mr. Paige's figures. When you realize that the total amount of gas sold in America last year was 2,348,000 million c.ft., of which by far the largest proportion was natural gas, you see the magnitude of the Industry there. It is also interesting to note that the revenue derived from the sale of gas only amounts to 1·96d. per therm, and the cost of manufacturing gas, as as far as my figures go, is 10·29d., as against natural gas, 1·06d. Of course, we have not got natural gas in this country, and the result is that we have to use our wits and produce in artificial ways as cheaply as we can. I was very much struck with what Mr. Paige said about salesmanship. We hear a lot about salesmanship in this country, but I do think that Mr. Paige has conveyed ideas to us in an entirely new manner this morning, and I am sure he will cause every member of the Institution to think on somewhat different lines from usual when we are thinking about salesmanship. It has occurred to me, also, that in America, with its enormously high buildings, you might have a perfectly satisfactory pressure on your service at the bottom of your building where the service enters, but an exceedingly poor one at the top of such a building.

Sir FRANCIS GOODENOUGH: When Mr. Paige sat down and you showed your appreciation of his speech, my neighbour on my right said, " I think we should like an encore," and I feel sure that that is the feeling of most of us. We would have liked to hear Mr. Paige talk even longer than he did, which was longer than he meant to. Don't you envy me the fact that I am going over to America in October to be present at the Convention of the American Gas Association over which Mr. Paige will preside? I envy myself anyhow. [Laughter.] I have had the privilege of meeting Mr. Paige several times since he has been in this country, and every time I meet him I learn from him, and I learn also to like him and admire him as a man as well as a gas expert. I am sure you have the feeling this morning that he is a man after our own hearts. [" Hear, hear," and Applause.] To attempt to discuss the paper would be foolish, and certainly would not be welcomed at this meeting, for there is enough matter in the paper to provide a week's discussion at a conference devoted to it. Certainly there is enough in it from the point of view of the commercial side of the Industry to keep a B.C.G.A. Conference going for two or three days, and it would be ill-becoming of me to review the paper or discuss it. What I feel we need principally to do is to express our great admiration to Mr. Paige and to Major Forward and the staff of the American Gas Association for having given us so complete a statement of the work of the Gas Industry in America to-day.

A PLAN ON WHICH TO WORK.

Just to make one or two comments upon what Mr. Paige said in that speech, which showed so much insight and foresight and sanity in reviewing the position of the Gas Industry to-day both here and in America, I would like to emphasize first of all the importance of thinking out and having a plan on which to work. I think that was the point in the paper that struck me most—the fact that the American Gas Association deliberately sat down and thought out what they should do on all sides of their activities for a period of five years. We in this country are too much inclined to go on, I think, from hand to mouth, from day to day, and from month to month in our work, and not to look ahead and plan, not merely in the Gas Industry, but in other industries; and what I shall take away from listening to Mr. Paige and reading his paper is the importance of deliberately setting out a programme of work and settling down to it. We certainly endorse the view he expressed that whatever we have done in the past to settle or solve our problems we have a great deal still to do in the future. The amplification of opportunity, to use a phrase which he used, is coming from every step that we take; every solution of a present problem at which we can arrive, as he said, gives us an amplification of opportunity for the future. Also I was very glad that emphasis has been laid on research and the importance of it, and I would only say that in regard to research I do not think of it only in terms of the laboratory and the scientific utilization of gas, but of research into all our marketing problems and salesmanship problems, as well as into our problems of distribution. As Mr. Paige said, preparation for the competition of to-day is one thing, but preparation for the competition of to-morrow and the future is another and a still more important problem for us to tackle. We have on both sides of the Atlantic a very great deal of hard thinking and work to do in the next five years to maintain, as we can maintain, and to increase, as we can increase, our business as an Industry. As Mr. Paige said, nothing can be done by hysteria and depression or fear, and I am sure that what struck me most, as it must have struck all of you, was the sanity of Mr. Paige's speech to us, the calm certainty of success provided we think and plan and work.

REFRIGERATION.

I hesitate to touch on any detail of the paper. I think we want to take away general ideas and general encour-

agement and a general sense of co-operation between the English-speaking peoples in the development and solution of our problems, but I would just like to emphasize one point of detail to which Mr. Paige referred because it is a very important point—and that is the question of refrigeration. I was very glad to hear what he said on that subject, because I feel that the Gas Industry in this country has not yet begun to take seriously the question of the development of the use of gas for refrigeration. In the States I notice they are developing it in the direction of cooling rooms in the hot weather as well as for the ordinary work we assign to refrigeration. They have shown us what can be done by a real selling plan or selling organization, a selling campaign in the development of the use of gas for refrigeration, and if we will bear in mind what he said so forcibly, that we can fire the imagination of the country with the thought of an entirely new use for gas, and give the sense that gas is not an old and decrepit Industry but a new, active, virile Industry producing new means of service to the public, then we shall welcome the refrigerator as a real stimulus to the business of the Industry.

I will not take up any more time, and I certainly will not touch in any more detail on Mr. Paige's most valuable paper and his most interesting talk to us. I would only like to express on my own behalf—and, I am sure, on yours also—our very warm thanks to Mr. Paige, and I think the best thing I can do when I get over on the other side is to ask as many members of the American Gas Association as can to come over here next year to the British Commercial Gas Association Conference so that we can thrash out together some of these problems which Mr. Paige's paper has opened up for us this morning.

Mr. G. M. Gill: I think the part I liked best about Mr. Paige's paper was the wonderful way in which he presented it. He made a lot of statistics and facts highly interesting to all of us in the way he addressed us and showed us—and his paper does the same—that gas is a very modern commodity. I think the more we emphasize that fact the better it will be for our Industry. Mr. Paige's paper, I think, will be widely quoted, as all the way through it he shows that gas is making wonderful progress in that most modern of countries, the United States. Mr. Paige and also Sir Francis Goodenough spoke of gas for refrigeration. Mr. Paige told us that in New York last year 30,000 gas refrigerators were sold to the public. Col. Fogg, who was the predecessor of Mr. Paige as President of the American Gas Association, told me, and I think it goes home more if I say he said, that they sold £1,000,000 worth of refrigerators in the year 1930 in the City of New York. I think that the public generally thinks that gas is a back number. One finds one's friends talking in that way; but the more we can impress upon them that it is anything but a back number, that it can do modern work in a modern way, the better it will be. In those two most modern of cities, New York and Chicago, gas is making wonderful progress. Chicago has claims for notoriety in other directions, but it is certainly very far ahead in the matter of gas. Mr. Paige shows in his paper what enormous quantities of gas are used in the United States. I took out some figures which, perhaps, make the position a little clearer. There were used in the United States last year 7½ times more therms for town supply than in the British Isles. I think that gives you a clear picture; and to show the progress that has been made in recent years I might say that in 1901 the consumption per meter for town supply was 24,000 therms, and that has grown to 43,000 therms in 1929. There are some features of the American Gas Association organization which we might copy here with advantage, and I think we should look into the advantages they have obtained through the use of their testing laboratory. I have been to their laboratories in Cleveland on two occasions, and there they test out all kinds of gas-using appliances, and they make suggestions to manufacturers how they can make improvements. The makers carry out such improvements, and the result has certainly been very much in the direction of improving gas using appliances. I must not take up any more time, but this really has been a most interesting morning listening to Mr. Paige's inspiring address.

Mr. W. T. Dunn: I, like everyone here, have been exceedingly interested in the paper of which Mr. Paige has given us such an excellent summary, and particularly in his introduction when he told us about that historic spot of the Gas Light and Coke Company which some of us know so well and in which hang the portraits of some of our early worthies. I take it that our friend Mr. Paige was also yesterday afternoon in the Council Chamber of our own Institution where hangs on the wall a portrait of another man whose memory is dear to many in this room, Sir George Livesey. He was a friend of most of us. I hope you will excuse this personal touch of reverence, but Sir George, as you know as well as I do, was responsible for some of the early work in our glorious Industry.

Now, may I ask one or two questions of Mr. Paige? Will he tell us where gas and electricity come into conflict in America? We know full well that some of your greatest undertakings are run by men who are gas engineers and also electrical engineers, and therefore your work there is different from ours here where very often we are brought into the closest and severest and most unfair competition. Our President hit out right from the shoulder—and we are very proud of our President for doing so on behalf of the Gas Industry—at the shameful treatment it is receiving at the hands of some of the corporations of this country who ought to know better. Mr. Paige is not faced with this difficulty, so that his position is quite different from our own, and we would like to know, therefore, in what respect the differences exist. I was particularly struck by the *credo* of the five-year programme. I think we might take a lesson there. Reference has been made by our President to a comparison of the organization of our Industry here and the Industry in America. If our Secretary or anybody else will examine the archives of this Institution they will find a pictorial representation of the Gas Industry of Great Britain in which a certain building, not many miles from this room, is shown supported by a series of very strong columns which represent the various departments of the Gas Industry. That building, I may tell you, is the Westminster Hospital, at that time up for sale for £250,000. Mr. Charles Hunt—this is history—came into my office and one morning offered £1000 to help to buy the hospital. It almost took my breath away, although I am rather accustomed to surprises, and then it occurred to me what an inspiring thought, and we went ahead and a Building Committee was formed, but it fizzled out. That building remains a hospital because the opportunity passed away from us.

A Home for the Institution.

What is our next step in the Gas Industry in Great Britain? Is it not that we should have some tangible evidence of our existence? Surely we do. There is this magnificent building of the Institution of Civil Engineers, our parent, and there is the home of the Institution of Electrical Engineers, formerly the examination hall of the Royal College of Physicians and Surgeons, and Mr. Paige will be interested to hear that we are on such friendly terms with them that they lend us their building most willingly. Yesterday we had their President here seconding the vote of thanks to our President, a most happy state of affairs; but we want a building of our own. We have our Charter, and had I remained Secretary one of my greatest ambitions was that after we received our Charter the next step should be to acquire a building for ourselves. It will be said that this must be expensive; of course it is. When I spoke of £250,000 a moment ago it gives some idea of what would be necessary. Perhaps to-day that must be considered a modest sum, but the money could be obtained by issuing bonds as the Institution of Mechanical Engineers has done. In that way we could get the necessary money, and therefore I think it is desirable for this Institution—and Mr. Paige has inspired us to-day—to consider what the next step should be. I venture to say it should be to acquire a building. Mr. Paige did not tell us where the headquarters of the American Gas Association are; but I believe they are in the large building which was built largely by the aid of money contributed by Mr. Carnegie. We have our offices in Grosvenor Gardens, but they are not worthy of the Institution of Gas Engineers, and I do hope that one of the results of the presentation of this paper will be that we shall have a house of our own. We are going to Paris in two years' time for a meeting in the Maison du Gaz and that is another point for our consideration. The Gas Industry in France and America is quartered in proper buildings, but in England that is far from being the case.

Mr. W. Sermon (Braintree): It seems to me remarkable that no mention has been made of cooling rooms by refrigeration. Perhaps it is not everybody who will put in a refrigerator for that purpose; but while people know they can buy gas ovens, I have never yet seen it mentioned that they can buy gas fans. Yet gas fans have existed for years and have been giving good service. One case that came under my notice was that of a fish shop. The proprietor had gas for cooking his fish and for lighting, but he said he must have an electric fan to help keep the place cool. I then told him of the existence of the gas fan and we fixed it. That has been the means of keeping electricity out of those premises altogether, and it is giving every satisfaction. Therefore, I should like to know if they have considered the use of gas fans in America.

The President: I will now call on Mr. Paige to reply, and we look forward to a further treat. In the meantime I should like to assure Mr. Dunn that the question of a suit-

able home for the Gas Industry in this country has not been overlooked. I think the Council has explored nearly every avenue which has been open up to the present, and they are fully aware of the necessity of what Mr. Dunn mentioned.

Mr. PAIGE, replying to the discussion, said: If there are any problems from competition that we do not have to face in America I should like to learn about them here. As a matter of fact we do have the most serious problems in competition in almost every phase of activity. Moreover, the marvellous research organizations of the tremendous electrical manufacturing companies, which seem to lie awake at nights until their hair turns white, are developing new appliances to such a degree that sometimes I wonder whether their purpose is to annihilate the Gas Industry. I said we are getting to be a nation of cliff dwellers, and we are trading centrally with enormous establishments. To give an instance, the Company with which I am connected has one customer whose gas bill is 3500 dollars a month for gas used for fuel in travelling bakers' ovens having a bread capacity of 1000 lbs. per hour. The electricity people came along and told the baker that it was too bad to bake bread in gas ovens and urged him to go over to electricity and told him that that marvellous fairy of civilization, electricity, would very soon supplant all other forms of fuel. Therefore, why should he put in gas apparatus which must certainly be taken out again within five years? That is what they say and that is competition. It all sounds wonderful to the person who is not following the developments in gas or electricity, and he does not know what to believe. We produce figures indicating that a unit of electricity contains 3400 B.Th.U., and then on to show how much better gas can do in this respect as regards heating equipment and in time we prove our case, but where we in the Gas Industry have one agency of research, the electrical people have infinite resources. That is what we have to meet.

AUTOMATIC ELECTRIC WATER HEATING.

The next thing is that in Fort Wayne there are a considerable number of houses wired for electricity. In what we call the attic of the house there is a large water tank, heavily insulated, and at 12 o'clock at night the automatic electric switch comes into operation and heats the water all night at a ridiculously low figure, something like half a cent per kw. At 5 o'clock, 6 o'clock, or 7 o'clock in the morning the switch automatically cuts the current off and the house is equipped with hot water for domestic purposes, and, moreover, hot water for heating the house, for the day. I submit that that is competition. That is the competition we have to prepare against. That is what we have to meet. You have heard a great deal about electricity generated by means of hydro-electric power. We have heard a great deal about the Ontario Hydro-Electric Commission and its marvellous schedule of rates. We have enough sympathy for the electric fellow in the States to realize that his problem is also a difficult one, but at the same time you know that in hydro-electric operation the uncertainty of the water supply has been proved in the States, and the cost of electricity at the switchboard is influenced by the uncertainty of the water supply. If that is the case, we have something to talk about, and we can say that the steam cost of electricity at the switchboard competes favourably with hydro-electric production in circumstances where the water is uncertain. But competition is by no means confined to water power States. It is inevitable that it will become national and international. Why not? If we were on the other side, we should say so. Then we get to this; we have automatic pressure controllers on the districts as you have and we can tell a good deal of the habits of the people. Before the prohibition laws were passed we discovered that the American got up at 7.30 and had breakfast at about 7.45. He had lunch and dinner at a certain time and went to bed at a certain time. We could tell all this because we had that bump in the pressure curve at breakfast time and at the other intervals during the day; but as time went on we found that these hours were advanced by something like an hour because the toast and the coffee is made on the table by electricity, as also are the eggs and the bacon on an electric grill. All that, I submit, is competition, and I may also add that we have plenty of competition in lighting.

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H.C.T.

Clean Coal in the Gas Industry

By R. LESSING, Ph.D., M.Inst.Gas E., F.I.C., F.Inst.F., M.I.Chem.E.

The Gas Industry has followed during the last 25 years a consistent policy of progress in all of its branches, and considerable advance has been made on the engineering side, particularly in the construction and operation of carbonizing plants, in the treatment and handling of gas, coke, tar, and ammonia, and, not the least, in the marketing and utilization of its final products. It is all the more remarkable that the raw material, to the rational and economic treatment of which the complex apparatus of a modern gas-works is directed, has received but scant attention, and no steps of a radical nature have been taken to select or prepare it so as to justify the efficiency of treatment subsequently given to it.

The conditions of carbonization, both on the plant and operation side, have been closely studied by scientific investigation and empirical experimentation, methods for the extraction of impurities and valuable products from the gas are continually being improved, the quality of the gas is controlled by statutory enactments, whilst the bye-products are refined and marketed according to definite standards.

Whilst the industry thus has generally organized itself for giving service, and bows to the requirements of the consumers of its products, it has hardly begun to assert its position as a large buyer of coal by insisting with equal force on the quality of its own raw material. True, many gas undertakings, and particularly the larger ones, are now buying their coal according to specification, or at any rate control its quality, but, as I hope to show in this paper, the customary standards are, technically and economically, not of a high order.

The character of the coals used for gas-works purposes was in the past mainly determined by their gas making qualities. This consideration began to lose its force with the change from an illuminating to a calorific standard, whereby, for instance, the use of cannel coal came immediately to an end. The introduction of vertical retorts showed up an inherent disability of typical gas coals, viz.—their swelling properties which cause certain difficulties in the free movement of a charge completely filling the retort space. The use of high carbonizing temperatures, large charges, and steaming have made it possible to bring a much larger variety of coals within the ambit of gas manufacture.

Considering that two-thirds or more of the weight of coal is obtained in form of coke, which represents rather more than one-half of the money value of the gas, it seems obvious that the value of the coal for coke making is of the utmost importance.

From this point of view the ash content of the coal is a vital and possibly the determining factor. The sale of gas coke is promoted on the strength of its being a smokeless fuel. From the commercial point of view, it is to be regretted that the sense of citizenship is not ingrained deeply enough in the individual to make him pay for advantages he would confer on the community by not polluting the atmosphere with smoke from his own chimney. The householder's first and perhaps sole consideration is his own comfort, avoidance of trouble and labour in dealing with ashes and clinker, and cleanliness of fireplace, kitchen, and cellar. A striking example in this direction is the failure, up to the present, of semi-coke as a domestic fuel, largely due to its leaving an excessive amount of ashes behind when prepared from the ordinary inadequately cleaned coal. Give the public a coke of minimum ash content and the abatement of atmospheric pollution will take care of itself.

The average ash content of the coke from undertakings with a supply of coal of what is now a normal quality may be taken as from 12 to 15 per cent. Many gas-works depending, owing to their geographical position, on the supply of coal of inferior quality, produce a coke containing from 15 to 20 per cent. of ash or more. This state of affairs is accepted with resignation, although it is now known that the bulk of British coals has an inherent ash content of only from 1·5 to 3 per cent., equivalent to from 2·2 to 4·5 per cent. of ash in the corresponding cokes.

Coal Components and Impurities.

It might be useful to re-state the results of modern researches into the constitution of coals. These show that ordinary banded bituminous coal consists of four main components, clarain, vitrain, durain, and fusain. The bulk of gas making coals consists of clarain and vitrain, the bright portion of a coal seam, with an ash content not exceeding 3 per cent., and sometimes even below 1 per cent. Durain, the hard, dull variety, preponderates in steam coals, and other non-coking or feebly coking coals; it has an ash content of 6 to 7 per cent. or more, mainly consisting of clay substance. A small but all-pervading portion of the seam, of the order of 3 to 5 per cent., consists of fusain, the mineral charcoal. It is friable, and hence is readily reduced to dust; it is the only portion soiling the fingers, and is entirely responsible for the dust occurring in all operations in and about the retort house. It is non-coking, and its ash content usually runs from 12 to 15 per cent.

The Rôle of Coal Components and Impurities in Carbonization.

From the gas makers' point of view clarain and vitrain are by far the most desirable constituents of a good gas coal. A reasonable proportion of durain may be admitted, and may be desirable in association with those coals which have a tendency to excessive swelling. Blends prepared from such coals with durain may be even desirable when a dense, hard coke is required, as in coke oven practice for metallurgical processes. The production of such coke brings with it the property of high ignition points which are a distinct disadvantage in cokes mainly designed for domestic or general manufacturing purposes. Moreover, the reduction of swelling power can be brought about by the addition of coke breeze, which when derived from clean coal has the added advantage of not increasing the ash content of the blend. The presence of fine dust, which comprises, though it does not entirely consist of, the bulk of the fusain content of a coal, has no value whatever in gas manufacture. The yield of gas and tar is relatively inappreciable, its caking power negligible in most coals, and very low in others; hence it is, together with the fine shale present in uncleaned or inadequately cleaned coal, the most prolific source of the production of breeze, which derives a large portion of its high ash content from it.

Apart from the coal components proper all raw coals or coals treated in washing plants of the ordinary type contain free particles of mineral impurities, such as shale, pyrites, and calcite or ankerite. These form the preponderating portion of the ash content of commercial coal. They are, of course, entirely valueless as sources of gas, tar, and ammonia. The shale has a decided disruptive effect on the coke, and when in larger pieces forms the " bats " in coke. Pyrites furnishes a large part of the sulphur in coal, thus entailing extra expense in gas purification and contaminating tar and coke with sulphur compounds. Calcite or ankerite (calcium iron carbonate) only yields carbon dioxide as volatile matter, and together with pyrites forms clinker-producing flux in coke ash.

Not only are these impurities entirely incapable of yielding the desired products of carbonization, but they interfere with the efficient conduct of the carbonizing process, by adding to the bulk of the coal to be treated for a given output of gas, by unnecessarily occupying valuable retort space, and by retarding the carbonizing time required for a definite charge through clogging the voids between coal particles with dust.

I have pointed out on previous occasions that the equivalent of the carbonizing capacity of the Gas Light and Coke Company would be required to " retort " the

ash content of the coal supplied to British gas-works. Whilst the capacity of this Company has considerably grown, and the mean ash content of gas coal has slightly diminished since this argument was first advanced, I still believe it to hold good, if the faster rate of carbonizing clean coal is taken into account.

In 1914 I called attention to the influence of catalysts on the carbonizing mechanism and have later shown the profound changes in the quantitative relation and the properties of the products according to the addition of different inorganic substances to the coal to be carbonized. The researches by Professor Cobb and his collaborators, based on this work, have proved my earlier contentions, and their results clearly demonstrate the subtle influences which may be at work when certain catalysts are added to the coal. It seems obvious that any practical importance which this recognition will, and as I think eventually must, assume presupposes the elimination of all or nearly all the chance impurities, before scope can be given to the directing influence of selected catalysts both in quantity and kind.

Coal Cleaning.

The question now arises whether, and, if so, how, coal can be prepared free from its injurious impurities and its legitimate, but for gas manufacture undesirable, constituents. Let it be stated at once that technically the problem has been solved completely both in principle and in all its details, some of which at the outset presented or appeared to present rather formidable obstacles. Coal washing has been practised for many years, and has at least in part mitigated the ash trouble. Applied as it mainly has been in the past to the slack and nut sizes, it has suffered from the inaccuracy of separation of coal from refuse, the formation of slurry with all its attendant troubles and losses, and the high moisture content of the products.

Methods of pneumatic cleaning introduced of recent years with the object of avoiding the high residual moisture of washed coal suffer from the disability of a still lower degree of accuracy of separation being obtainable than in processes depending on the use of water, particularly in the smaller sizes, and of the slurry difficulty being replaced by a pronounced dust nuisance.

The author's investigations into the mineral constituents and impurities of coal and their distribution over its components compelled him to the conclusion that the rational way of tackling the problem lay in the direction of the application of the laboratory method commonly applied to the testing of coals for their washability, and of washing plants for efficiency of performance—the so-called float-and-sink test—on an industrial scale.

Many difficulties were anticipated in a process which implied the use of solutions of a density higher than water, the given medium being, on account of cheapness, calcium chloride; of these, corrosion of plant, incomplete removal of chloride, losses of this salt, and possible action on coal or shale might be cited. By intensive research work, successively on a laboratory, semi-technical, and commercial scale, these difficulties were either found to be non-existent or they were successfully overcome. It may be confidently stated that the process is now established on a sound industrial basis, as is evidenced by a number of installations having been put up or being in course of erection.

The "Clean Coal" Process.

The process has been described on a number of occasions, and particularly, as applied to gas-works purposes, in a paper before the Southern Association of Gas Engineers and Managers (Eastern District).

In brief, it consists of the introduction of the coal to be cleaned into a bath of calcium chloride solution of the appropriate specific gravity, in which the clean coal rises and the heavier refuse sinks. The former is skimmed off the surface by a light push-plate conveyor, and the latter dredged out from the bottom by a bucket elevator. Both are then freed from the adhering calcium chloride solution by replacing it with water in specially designed drainers, and the residual weak liquor is completely rinsed off by water which itself is then drained off.

The weak liquor formed is re-concentrated in a steam heated evaporator and returned into circulation, whilst only a negligible portion equivalent to about half-a-gallon of strong calcium chloride liquor per ton of coal is run to waste as its concentration would not be economical.

In order to facilitate, or even make possible, the rapid and complete removal of chloride and of washing water, the natural dust (comprising nearly all fusain and shale dust) is previously extracted from the coal by a pneumatic process, and in order to obtain the high efficiency desired which was not possessed by existing de-dusting appliances, new equipment had to be designed. This is based on the principle of elutriation by means of air, and permits a sharp cut to be obtained between the true dust and the de-dusted coal, so that the latter contains no more than 1 per cent. of dust, whilst the former is practically free from cleanable coal. The freedom from porous dust of the coal fed into the gravity separator is responsible for the remarkable draining rates obtainable which permit the calcium chloride to be completely extracted from a charge of 30 to 40 tons, and the water to be drained off in less than two hours. This extraction and drainage is so thorough that the coal on discharge usually contains only about one-half the chloride percentage of the raw coal, and in the case of small slack or duff only 5 per cent., or in nut sizes about 3 per cent. of free moisture.

Experience in practical working has shown that even moist coal can be efficiently de-dusted, and recent improvements allow of fractions higher in specific gravity than the solution itself, being floated and either added to the clean coal or taken off separately for other purposes, such as steam raising.

Products Obtained.

The bulk of any raw coal is obtained in form of clean coal. This is strikingly different in appearance, physical character, and chemical composition from the original coal. It is brighter, does not soil the fingers, is clean to handle, coarser in grading than the raw coal and, of course, of much lower ash content. Of the many hundred samples examined, a number of which were treated on a commercial scale, there are few containing more than 3 per cent. of ash. Typical Durham and Yorkshire gas coals usually yield a "clean coal" containing from 1·5 to 2·5 per cent. of ash.

In comparing these figures with the ash percentage of coals washed in the most up-to-date plants of the older type, which rarely go below 6 per cent. and then only by sacrificing yield, it should be realized that such differences correspond to the addition of (say) 200 per cent. of extraneous ash, widely varying in chemical composition, to the inherent ash of the pure coal substance. The free moisture, according to size, ranges from 3 to 5 per cent.; sulphur is considerably lower, and the chloride content about one-half that of the raw coal. The particles are not covered by a film of clay such as is deposited on coal during the water washing process, an important factor bearing on the strength of coke obtained. The coal, even if all below $\frac{1}{8}$ in., runs very freely from bunkers or chutes and finds its own level very readily without "hanging up." As will be shown below, it is an ideal material for carbonization.

The dust (smaller than 1/100 in.) present in the slack sizes to an extent of about 5 to 10 per cent. on average, is on account of its fusain content very different from the true clean coal. It contains ash as an incrustated deposit much in the nature of boiler scale which cannot be extracted by physical means. It is non-coking in most and feebly coking in some coals, but its carbonizing value is in all cases very much inferior to that of the clean coal. The given use of the dust is for boiler or furnace firing as by substituting it for pulverized coal, grinding costs and wear and tear on mills can be saved, while its combustion efficiency is at least as high as that of powdered fuel of the same ash content.

If desired, it can, of course, be added back to the clean coal, but this alternative has nothing to commend it for gas-works purposes, as the dust, together with the small refuse, forms the principal source of breeze and dust in coke. In fact, it is little changed during carbonization, and therefore takes no part in actual coke formation.

Moreover, from the gas making point of view the

absence of the smallest sizes is of enormous importance. It is an established fact that by sizing coal and particularly by eliminating smalls (say) below $\frac{1}{8}$ in., carbonizing speeds are considerably enhanced. However, our views regarding the limit of size below which these rates are appreciably retarded require some modification in the light of experience with clean coal and dust-free coal. This tends to show that the fraction responsible for the slowing-down of gas making rates is the true dust, of a maximum particle size of 1/100 in. In large-scale coke oven tests it has been found that " clean coal " was fully coked in 14½ hours, whilst ordinary washed coal made from the same raw fuel required 17½ hours under the same conditions of carbonization. In other tests corresponding reductions from 26½ to 22½ hours and 37 to 28 hours were obtained. The results in vertical retort working of another coal indicate a similar speeding-up of carbonization in gas retorts.

My explanation of this remarkable difference in behaviour is that the fine and porous dust attached to the surfaces of the coal particles absorbs the tar and pitch which clog the interstices, eventually become carbonized, and thus impede the free passage of the gas and particularly of further tar vapours. In the absence of such dust and of the finer refuse, the gas sweeps freely past the smooth coal surfaces, just as a saturated solution of calcium chloride drains unimpeded through the mass of coal. Furthermore, free play is given to the fusing and merging together of the clean surfaces of adjacent particles free from dust and clay film, a factor which largely accounts for the higher quality of coke produced from clean coal.

The remaining product is the refuse consisting of shale, pyrites, and the carbonates of lime and iron. In some coals the cut between clean coal and refuse is exceedingly sharp and the discard from the process contains no true coal at all, although the shale, being mostly of the carbonaceous kind, has some carbon associated with it, which, however, cannot be extracted by physical means. In other coals the transition is not so abrupt, owing to a small fraction of (say) from 3 to 5 per cent. of a coal of high ash content (20 to 30 per cent.), and rich in durain, being present which has a definite though smaller fuel value. Recent improvements have made it possible to extract this portion as a separate and definite product, free from either clean coal or refuse. This forms a fuel which can be readily burned on modern boiler grates, but has little value for gas or coke making. If this middle product is left with the refuse the carbon content of both can be utilized advantageously in steam raising, provided no cost of transport is incurred. Such material has been used for several years in combined producer-boilers as the sole fuel for the steam requirements of the first Clean Coal Plant erected.

Cleaning Results.

Several hundred coal samples of most kinds of British and of many foreign coals have been quantitatively examined on the lines indicated, and with few exceptions in the case of some exotic coals, have shown that the bulk can be obtained in form of a low-ash product with a moderate quantity of fine dust, whilst the balance consists of refuse of low carbon content and equivalent in calorific value to rather less than 5 per cent. of the total.

A considerable number of coals have been submitted to large-scale treatment in a commercial plant in quantities of 100 tons or more, and the results tallied in every case very closely with those obtained in the laboratory or on a semi-technical scale.

In Table I. the yields and principal analytical characteristics obtained in such large-scale trials from four coals of a coking or gas type are recorded as examples.

Carbonization of Clean Coal.

The consignment referred to in the last column of Table I. was submitted to comparative carbonizing tests in continuous vertical retorts at the Willoughby Lane Works of the Tottenham and District Gas Company. These tests have already been referred to by Mr. H. C. Smith, M.Inst.C.E., M.Inst.Gas E., in his recent Presidential Address to the Southern Association of Gas Engineers and Managers, but it may be useful to repeat here the numerical data given by him.

Table I.

	Welsh.	Yorkshire.	Yorkshire.	Yorkshire.
Screen Size	1¼ in. - 0.	½ in. - 0.	⅜ in. - 0.	1 in. - 0.
Yields of Products (air-dry basis)—	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Dust	12·8	6·0	14·6	6·3
Clean coal	65·2	71·9	64·0	79·4
Refuse	22·0	22·1	21·4	14·3
Total Products	100·0	100·0	100·0	100·0
Free moisture (as discharged)—				
Dust	0·9	3·8	2·4	3·1
Clean coal	3·6	5·6	6·1	5·6
Refuse	4.2	13·2	6·5	8·9
Original sample	2·6	2·6	1·5	0·2
Ash in products (air-dry basis)—				
Dust	9·64	16·59	8·90	12·91
Clean coal	2·86	3·14	2·82	1·66
Refuse	57·85	53·38	38·63	40·95
Original sample	15·80	15·06	11·38	8·01
Volatile matter less moisture (air-dry basis)—				
Dust	25·16	25·89	31·09	24·91
Clean coal	25·86	33·18	34·72	35·79
Refuse	16·53	21·56	25·07	23·38
Original sample	23·72	30·18	32·12	33·31
Chloride in terms of Cl (as discharged)—				
Dust	0·003	0·013	0·010	0·562
Clean coal	0·014	0·010	0·007	0·090
Refuse	0·040	0·046	0·026	0·077
Original sample	0·004	0·019	0·007	0·173

For these tests 350 tons of a Yorkshire gas coal, having passed a 1 in. screen, were taken; 100 tons were sent direct to the Willoughby Lane Works, whilst 250 tons were consigned to Ynisceedwyn Colliery, South Wales, to be passed through the Clean Coal Plant, with the results stated in Table I. The clean coal obtained was then sent to Willoughby Lane for carbonization.

Special care was taken to ensure the accuracy of sampling of the raw coal. This was carried out according to the specification proposed by the B.E.S.A., and as a precaution against the variation in quality of the coal during loading, alternate wagons were marshalled so as to make up trains for Tottenham and South Wales. A very good agreement was obtained in the analysis of the samples from the different points. Similar arrangements were made for the sampling of the products from the cleaning process and for the coke.

Table II. shows the screen analysis of the products obtained and of the original coal. The marked difference in grading between the clean coal and the refuse, even if allowance is made for the abstraction of dust, tallies with the usual experience that the refuse from slacks is smaller in grading than the clean coal, a fact of considerable practical importance for the ready release of gas during carbonization.

Table II.—*Screen Analysis.*

—	Dust.	Clean Coal.	Refuse.	Original Sample.
Through 2 in. .. On 1 in.	..	1·9	..	1·5
1 " .. ½ "	..	30·3	13·6	25·9
½ " .. ⅜ "	..	12·8	6·1	11·0
⅜ " .. ¼ "	..	21·8	11·7	19·1
¼ " .. 5 IMM.	..	15·2	19·9	14·9
5 IMM. .. 10 "	..	9·2	20·7	10·3
10 " .. 20 "	..	5·2	15·9	6·5
20 " .. 50 "	..	2·5	7·9	4·6
50 " .. 100 "	34·8	0·5	2·2	2·4
100 " .. 200 "	35·8	0·2	0·8	2·0
200 " . . .	29·4	0·4	1·2	1·8
	100·0	100·0	100·0	100·0

The same four retorts were used for both tests and the conditions of carbonization were identical for the uncleaned and the clean coal.

As both consignments had to be carbonized under ordinary works conditions, and as it was not possible to isolate the foul gas main from the remaining part of the retort house, nor to allow the feed bunkers to become quite empty before and after the test, the yields of products of carbonization could not be quantitatively ascertained. An indication of the difference in behaviour of

the two coals is afforded by the laboratory carbonization assay.

Lessing Carbonization Assay.

—	Uncleaned Coal.	Clean Coal.
Temperature of coking (B.E.S.A. standard), ° C.	968	968
Duration of heating, mins.	7	7
Coke, per cent.	63·38	59·87
Tar, ,,	13·20	13·85
Liquor, ,,	7·99	10·00
Gas N.T.P., cc. per gram	248	266
,, ,, , c.ft. per ton	8870	9540
Expansion of coke, per cent.	10	*Nil*

In considering the carbonization assay, it should be borne in mind that the results are not those to be expected in practical gas making, but are strictly comparable under the working conditions fixed by the British Engineering Standards Association. Under these conditions a minimum of thermal decomposition takes place, and in consequence the tar is preserved at the expense of the make of gas. Moreover, the formation of retort carbon is reduced to a minimum, and hence the coke yield is somewhat lower.

Both coals were put through the retorts at the same rate. The chemical and physical properties of the coke from clean coke showed clearly that its rate could have been very considerably increased over the other without fear of inadequate carbonization.

The difference between the two types of coke was very marked indeed, and can best be gauged from the following table:—

—	Coke from Uncleaned Coal.		Coke from Clean Coal.	
	Yield.	Ash.	Yield.	Ash.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Grade I.— On 2 in.	38·3	7·91	57·2	3·15
Grade II.— Through 2 in. On 1½ in.	26·9	9·55	24·5	2·93
Grade III.— Through 1½ in. On ½ in.	19·9	16·19	10·8	3·18
Breeze— Through ½ in.	14·9	25·78	7·5	3·63
Total coke	100·0	12·78	100·0	3·13

Two important facts become manifest from these results. Firstly, the percentage of large coke from clean coal is greatly increased, whilst the percentage of breeze is halved. Secondly, whilst the ash content of the coke from uncleaned coal rises with decreasing size to nearly 26 per cent. in the breeze, the ash in the four grades from clean coal remains constant throughout at the remarkably low average figure of 3·1 per cent. The obvious inference is that the clean " breeze " cannot be regarded as a low-grade fuel, and that on account of its negligible ash content it can be put to uses, in spite of its size, for which ordinary breeze could never be considered. The total revenue from coke is therefore greatly enhanced by reason of total yields quite apart from its higher fuel value.

The appearance of the coke strikingly exhibits its superiority over that from uncleaned coal, or, for that matter, over ordinary gas cokes.

The coke is less fissured, entirely free from " bats," clean to the touch. It is harder, slightly denser, and no less ignitible than that from the uncleaned coal. In that connection it should be remembered that in order to keep conditions constant in both tests, carbonization was unnecessarily prolonged in the case of clean coal.

A quantity of both cokes was submitted for test to the Fuel Research Station with the principal result that the clean coke gave a very high maximum rate of radiation, considerably above that of the coke from uncleaned coal, whilst the latter was found altogether unsatisfactory in the well-type grate. Both were compared with low-temperature coke, and were found inferior to it in one respect—*i.e.*, ease of ignition, a result which was, of course, to be expected.

Samples of the coke have been tested by various other authorities with outstanding results, but the results are not available for publication.

The behaviour of the clean coke in a domestic boiler was observed over a period of nine months during which the fire continued to burn without intermission. The constancy of hot water supply, the convenience and cleanliness in handling, the total absence of clinker, and the small amount of ash removal required, impressed the staff to such an extent that the necessity of reverting to ordinary coke, after the available supply had run out, caused a certain amount of domestic upheaval.

The results obtained from a number of comparative trials in coke ovens corresponded in principle and details to those described.

Use in Carburetted Water Gas Making.

Comprehensive tests were carried out for the purpose of assessing the value of the two types of coke for water gas making. The Humphreys & Glasgow plant at the Ponders End Works of the Tottenham and District Gas Company, which is a hand-operated installation, was selected for these tests. Grade I. coke was used in both cases, hence the ash content of the coke from uncleaned coal, being 7·9 per cent., was actually lower than that of the coal, whilst that in the clean coal, at 3·4 per cent., was practically equal to the average of the total coke made. In view of this low percentage of ash it is reasonable to expect that the " clean " coke could be used in unscreened condition, even containing its quota of breeze, with the same efficiency as the large coke, as the smaller size would be gasified readily without clogging the interstices with ashes or clinker.

The tests were supervised jointly by the chemists of the Tottenham Company and by my own assistants, together with members of the research staff of the Clean Coal Company. Observations were taken of all relevant operations, and coke, gas, and clinker were sampled jointly with due care, the supervisors working in three shifts throughout the test periods.

Clinkering.

The most remarkable difference between the two cokes in the manufacture of water gas was the difference in the amount and rate of clinker produced. Whilst in the test on " uncleaned " coke the generator was clinkered on the usual schedule every eight hours, the run with clean coal did not require the withdrawal of clinker before the lapse of 47 hours. In consequence, the total time occupied in clinkering was halved, and would, in practice, not occupy more than one-quarter of the normal time if the generator would not be allowed to go on for two days without any ash being extracted. I estimate that with regular clinkering once a day, the time occupied should not be more than 30 minutes, as against the 118 minutes actually observed with the ordinary coke. The total clinker formed and extracted from the " uncleaned " coke was 8 per cent., and that from the clean coke only amounted to about 1 per cent., whilst the reduction in pan ash was of the same order.

Steam Required.

Whilst the steam raised in the waste heat boiler during the test on " uncleaned " coke was about 17 per cent. less than that required for gasification, in the test on clean coke an excess of steam was actually produced over that required by the generator.

Operating Results.

The principal results are recorded in Table III. An outstanding fact is the large increase in gas or therm production per hour, amounting to 39 per cent. Slightly more oil had to be used in the test with " clean " coke, in order to bring the surplus water gas made up to the required standard of the district, but this did not seriously affect the result.

Steam requirements with " clean " coke were only 72·3 per cent. of those for ordinary coke, whilst the clinkering time was reduced by 48·3 per cent., and could be reduced still further by clinkering at least once in 24 hours.

The explanation for the increase in make and calorific value of the gas must be sought in the greater speed with

which both blowing and steaming take effect on account of the absence of ash or clinker and the consequent decrease in lag of the reaction with carbon, of oxygen and steam in the beginning of the respective periods of the cycle.

TABLE III.—*Carburetted Water Gas Tests.*

—	Coke from Uncleaned Coal.	Coke from Clean Coal.
Gas made per hour, c.ft.	24,600	30,100
,, ,, ,, ,, therms	105·5	138·0
Gas made per lb. of coke, c.ft.	30·3	30·2
,, ,, ,, ,, ,, therms	0·131	0·140
Coke used per 1000 c.ft. of gas, lbs.	32·8	33·0
Oil used per 1000 c.ft. of gas, galls.	1·69	1·78
Steam to generator per 1000 c.ft. of gas, lbs.	40·8	29·5
Clinkering time per 24 hours, mins.	118	61
Clinker, per cent. of coke used	8·2	1·2
Pan ash, ,, ,, ,,	7·3	1·7
Analytical results—		
Coke—		
Moisture, per cent.	1·0	1·1
Ash ,, ,,	7·9	3·4
Clinker—		
Moisture, per cent.	1·5	2·3
Ash ,, ,,	83·2	98·2
Pan ash—		
Moisture, per cent.	9·1	2·1
Ash ,, ,,	69·2	62·4
Purified gas—		
CO_2 per cent.	8·8	5·3
O_2 ,, ,,	1·3	0·2
C_nH_m ,, ,,	4·9	5·4
CO ,, ,,	27·5	35·4
H_2 ,, ,,	39·4	40·1
CH_4 ,, ,,	10·1	10·7
N_2 residual, per cent.	7·1	2·9
Per cent.	99·1	100·0
Calorific value (calc. from analysis), B.Th.U. per c.ft.	428	475
Calorific value (Boys calorimeter), B.Th.U. per c.ft.	424	463

Economic Considerations.

Having demonstrated by large-scale tests that the general proposition of the advantages of clean coal in carbonization and gasification is feasible in practice, technically sound, and therefore commercially desirable, the question now arises: Does it pay? There is a common idea abroad that on account of cost of cleaning operations and loss of tonnage, the use of truly clean coal for gas-works purposes is economically out of question. I have given much attention to this problem, and have examined it for a considerable time in great detail, and in this work have had the benefit of helpful criticism from some of those best qualified to judge.

For the purpose of stating a case and illustrating the commercial aspect of the question, I have constructed an Expenditure and Revenue Account (Table VI.), in which the carbonization of clean coal is compared with that of the same coal before cleaning, but having a reasonable ash content. It should be clearly understood that the basis figures cannot claim general applicability, but have been selected by way of example. For this purpose the results from the test of Yorkshire coal made in conjunction with the Tottenham Company have been used. As in that cleaning test the plant was not specially adjusted for that coal, a small percentage of middle product (4·2 per cent. containing 11·26 per cent. of ash) was left in the refuse. For the present calculations this middle product was assumed to be recovered together with the clean coal, thereby raising its ash content from 1·66 per cent. to 2·14 per cent.

Analytical and other data for the two kinds of coal are given in Table V. The cleaning results and basic cost figures appear in Table IV. A definite therm yield has been taken as a convenient basis of comparison; for this purpose carbonizing conditions are assumed under which the uncleaned coal will yield 72 gaseous therms per ton. Against this is set the equivalent quantity of clean coal, which also yields 72 therms, and it was found that this quantity is 0·903 ton. This ratio will also apply where carbonizing conditions are employed which give other yields of gaseous therms within the customary limits.

For the present example a case was chosen in which the coal is cleaned at the colliery or at a central station in the colliery district. Similar calculations have been made, but are not recorded here, for cases where the cleaning plant is situated at the gas-works.

The Expenditure and Revenue Account appears in Table VI., and should be self-explanatory.

The significance of the account is that it shows a total expenditure, in the manufacture of gas equivalent to 72 therms, of 35s. 7·3d. in the case of uncleaned coal, against 33s. 10·5d. in the case of clean coal, or a saving of 2s. 2·3d. per ton of the former, although the uncleaned coal is probably of higher quality than the average kind used by the industry to-day.

The statement has been prepared on what is thought to be a conservative basis, and certain credits have not been drawn upon which will without doubt accrue from the use of clean coal, such as higher carbonizing speed, higher quality of tar, lower maintenance costs on account of freedom from dust in retort house, reduction in sulphur emission from producers and C.W.G. generators, avoidance of coke and breeze washing, lower distribution costs for coke, and the value of general amenities.

TABLE IV.—*Particulars of Coal Cleaning.*

—	Yield of Products. (Air-Dry.)	Ash in Products. (Air-Dry.)
	Per Cent.	Per Cent.
Dust	6·4	13·96
Clean coal	83·6	2·14
Refuse	10·0	63·70
Original (total products)	100·0	9·05

EXPENDITURE.

Incurred in Cleaning 1 Ton of Coal.

	s.	d.
Original coal at pit	11	0
Cleaning	0	5
	11	5

REVENUE.

Resulting from Cleaning 1 Ton of Coal.

	s.	d.
Dust : 0·064 ton at 10s. per ton	0	7·7
Refuse : 0·10 ,, —no credit taken	..	
Clean coal : 0·836 ,,	10	9·3
	11	5
Cost of clean coal air-dry, per ton	12	10·7
Cost of clean coal equivalent to 1 ton of uncleaned coal (on basis of gaseous therms)	11	7·7

TABLE V.—*Analysis of Coals Carbonized.*

—	Uncleaned Coal.	Clean Coal.
	Per Cent.	Per Cent.
Sample as received—		
Moisture	4·27	4·34
Volatile matter, less moisture	33·13	35·60
"Fixed carbon"	53·55	57·92
Ash	9·05	2·14
	100·00	100·00
Sulphur	1·47	1·14
Coke yield	62·60	60·06
Dry ash-free coal—		
Volatile matter	38·22	38·07
"Fixed carbon"	61·78	61·93
	100·00	100·00

Comparison of Cokes Obtained.

	Per Cent.	Per Cent.
Dry basis—		
Ash in—		
Large coke and nuts	12·40	3·51
Breeze	25·78	4·14
Total coke	14·45	3·56
Equivalent weights on basis of calorific value—		
Large coke and nuts	1·000	0·908
Breeze	1·000	0·774
Total coke	1·000	0·887

Comparison of Yields.

Equivalent weights of coal carbonized to give 72 therms, tons	1·000	0·903
Gas, therms	72	72
Large coke and nuts (dry basis), cwt.	10·65	10·03
Breeze (dry basis), cwt.	1·87	0·81
Tar, galls.	15·4	14·6
Liquor, galls.	30	30

TABLE VI.

EXPENDITURE Incurred in Carbonizing Equivalent Weights of Coal.	Uncleaned Coal.	Clean Coal.
Weight of Coal required, tons	1·000	0·903
	s. d.	s. d.
Coal—		
At 11s. per ton at pit head	11 0·0	..
At 12s. 10·7d. per ton at pit head.	..	11 7·7
Transport at 13s. per ton	13 0·0	11 8·9
Ash removal and disposal—		
0·434 cwt. at 5s. per ton	0 1·3	..
0·072 ,, ,, ,, ,,	..	0 0·2
Purification	0 4·0	0 3·7
Carbonizing wages	2 6·0	2 3·1
Maintenance and repairs	4 6·0	4 0·7
Power costs	0 9·0	0 8·1
Gas used on works other than power	0 2·0	0 2·0
Salaries	0 9·0	0 9·0
Total expenditure (excluding capital charges)	33 1·3	31 7·4
Capital charges	2 6·0	2 3·1
Total expenditure	35 7·3	33 10·5

REVENUE Resulting from Carbonizing Equivalent Weights of Coal.	Uncleaned Coal.	Clean Coal.
Weight of Coal required, tons	1·000	0·903
	s. d.	s. d.
Coke—		
Made 12·52 cwt.		
Retort house fuel 3·00 ,,		
For sale 9·52 cwt. containing—		
Large, 8·10 cwts. at 24s. per ton	9 8·6	..
Breeze, 1·42 ,, ,, 7s. 6d. per ton	0 6·4	..
Coke—		
Made 10·84 cwt.		
Retort house fuel 2·01 ,,		
For sale 8·83 cwt. containing—		
Large, 8·17 cwt. at 26s. 5d. per ton	..	10 9·5
Breeze, 0·66 ,, ,, 9s. 8d. ,, ,,	..	0 3·8
Tar—		
15·8 gallons at 4d. per gallon	5 3·2	..
14·6 ,, ,, 4d. ,, ,,	..	4 10·4
Liquor, 30 gallons at 0·5d. per gallon	1 3·0	1 3·0
Total for residuals	16 9·2	17 2·7
Value of gas into holder	18 10·1	18 10·1
Total revenue	35 7·3	36 0·8
Total expenditure	35 7·3	33 10·5
Saving by use of clean coal	..	2 2·3

A 20 per cent. increase in efficiency has been allowed for retort house fuel from clean coal.
Coke for sale from clean coal has been assessed strictly on a calorific basis, no credit being taken for greater convenience and efficiency in burning, and cleanliness in handling and ash removal.
Cost of washing coke from unclean coal not debited.

It was considered right to assess the price of clean coke and breeze not lower than on the calorific basis, for it seems hardly fair that the gas undertaking should pay a higher price for its coal, but should not obtain a corresponding increase for its coke.

However, in order to forestall criticism on this score and on the assumption that the high-grade " clean " coke cannot be sold at a higher rate than the present high-ash article, the revenue for clean coke and breeze was also calculated on a weight basis irrespective of quality—*i.e.*, at 24s. per ton for large coke and 7s. 6d. per ton of breeze, and Table VII. may give comfort to those who believe themselves worse salesmen than they ought to be and probably are.

It will be seen that even on this pessimistic basis there is still a saving of 1s. 1·6d. per ton.

TABLE VII.—*Revenue, assuming same Price per Ton for both Cokes.*

—	Uncleaned Coal.	Clean Coal.
	s. d.	s. d.
Coke for sale 9·52 cwt. containing—		
Large 8·10 cwt. at 24s. per ton	9 8·6	..
Breeze 1·42 ,, ,, 7s. 6d. ,,	0 6·4	..
Coke for sale 8·83 cwt. containing—		
Large 8·17 cwt. at 24s. per ton	..	9 9·6
Breeze 0·66 ,, ,, 7s. 6d. ,,	..	0 3·0
Tar and liquor	6 6·2	6 7·4
Total for residuals	16 9·2	16 2·0
Value of gas into holder	18 10·1	18 10·1
Total revenue	35 7·3	35 0·1
Total expenditure	35 7·3	33 10·5
Saving by use of clean coal	..	1 1·6

The accounts presented in Tables VI. and VII. deal only with the carbonizing side. It is, however, obvious from the results of the water gas tests that the influence of the use of clean coal, and of the coke made from it, is also of very great importance for the economics of water gas manufacture.

In Table VIII. a statement is given comparing the cost per therm of carburetted water gas made from the two kinds of coke. The basis figures for quantities are those ascertained in the tests at Ponders End, whilst the money values have been fixed on the lines previously discussed. It will be seen that the cost of producing carburetted water gas is 3·27d. per therm with coke from uncleaned coal, against 3·024d. from clean coal, or a saving in the case of the latter of about ¼d. per therm.

TABLE VIII.—*Particulars of C.W.G. Manufacture.*

Coke Used	Coke from Uncleaned Coal.	Coke from Clean Coal.
Coke used per therm, lbs.	7·65	7·27
Oil ,, ,, ,, galls.	0·39	0·37
Steam ,, ,, ,, lbs.	9·53	6·50
Calorific value of gas made, B.Th.U. per c.ft.	429	454
Gas made per 24 hours, therms	2530	3280
Clinkering time per 24 hours, hours	2	0·5

Expenditure Incurred per Therm of Carburetted Water Gas.

	d.	d.
Coke at 20s. per ton	0·82	..
,, ,, 22s. 2d. per ton	..	0·86
Oil at 4¼d. per gallon	1·66	1·57
Steam at 2s. 6d. per ton	0·12	0·09
Labour—		
Gas making at 1s. 3d. per hour	0·14	0·11
Clinkering ,, 2s. 2d. ,,	0·02	0·004
Purification	0·05	0·03
Total expenditure (excluding capital charges)	2·81	2·664
Capital charges	0·46	0·36
	3·27	3·024

Cleaning at Colliery.

The preparation of the Expenditure and Revenue Account was based on the assumption that the coal is cleaned at the colliery. The question of the allocation of the saving has been disregarded. Some of it the colliery will claim in respect of recompense for the enterprise of putting down and operating the cleaning plant, although the capital charges for interest and depreciation for this plant have already been included. The balance will be a direct saving in the cost of gas manufacture.

As the net result, an expenditure which at present is non-productive and unprofitable will be avoided for the

benefit of the colliery, the gas undertaking, and the consumer of gas and coke.

Cleaning at Gas-Works.

Cleaning at or near the pit is the obvious course of procedure, and the mining industry should be required to prepare its products in the form best suited to the needs of its customers. The present economic state of that industry with its financial difficulties will, however, make it advisable in certain cases to proceed with cleaning operations at the gas-works.

Calculations made on this basis show that, although the saving will be smaller on account of cost of freight of refuse contained in the coal and its disposal after cleaning, there still remains a credit balance in favour of the clean coal. Even assuming that in such a case a direct profit may not be anticipated, the possibility of disposing at all times of the whole output of coke of the highest quality in competition with the ordinary inferior commodity should be a potent factor in favour of such a policy.

Conclusion.

The Gas Industry has attained its position in the community, and is consolidating it by the steady expansion of gas consumption largely through its deliberate policy of giving good service to its gas consumers. The first and foremost condition of this service is the meticulous care with which the quality of gas, its freedom from impurities, and the constancy of supply is controlled and maintained. It seems only logical that similar attention should be paid to the preparation of coke, which is the main product of carbonization from the point of view of weight balance, and the next to gas in money value, and that consideration should be given to the consumers of coke on corresponding lines.

A good deal has been said and written during recent years on the need for an improvement in the quality of gas coke and its influence on the fuel market. Some improvements have been made, but they signified variations in degree rather than fundamental changes. It is hoped that this paper has satisfactorily demonstrated the practical feasibility of a rational improvement of the quality of coke, and that this can be obtained not only without any addition to the cost of gas manufacture, but actually at a profit and for the benefit of all concerned.

DISCUSSION.

The President: I am sure we are under a debt of gratitude to Dr. Lessing not only for his very interesting and instructive paper but also for the extremely interesting and illuminating way in which he has commented on the subject he has dealt with this morning. Dr. Lessing I may say submitted this paper at my personal request. I know he is a very busy man, and I think we can at this stage express our gratitude to him for the time and trouble he has taken. Whatever comments I may make on the paper are by way of extracting further information rather than venturing to criticize the paper. I should like to ask, in the first instance, what is the gravity of the calcium chloride solution that he uses. In the paragraph dealing with the ash content of the coke the author does not mention the moisture content of the coke, which is probably just as vital a factor as the ash content, because it influences the behaviour of the coke during combustion. In the last sentence of the paragraph, Dr. Lessing is inclined to be unduly optimistic when he says "Give the public a coke of minimum ash content, and the abatement of atmospheric pollution will take care of itself." I think that is rather too optimistic, because when we have anything to sell we must tell the people what we have to sell and what it will do when we have sold it to them.

With reference to the paragraph giving figures for the average ash content of gas-works coke, I certainly do not entirely agree with Dr. Lessing, and I will give you the figures of the ash in the coke which has been produced at the Hull station. The figures for the last few years, which are the average from a very large number of tests, are as follows: In 1925 the ash in our coke was 9·53 p.ct.; in 1926 it was 12 p.ct. That was the year of the General Strike. In 1927 the figure was 9·3 p.ct., and that was the aftermath of the Strike, because we had some of the material left, and I will not tell you where it came from. Some of it came from across the Atlantic, and it was very full of dust. In 1928 the amount was 5·98 p.ct.; in 1929 it was 5·94 p.ct.; in 1930 it was 6·33 p.ct., and in 1931 to date it is 6·14 p.ct. The average for six years is 7·21 p.ct., and that will probably correspond to an ash content in the coal of something like 5 p.ct. It is also interesting to know that from the beginning of 1928 the average ash content of the coke has been only 6·09 p.ct., and the ash content in the coal corresponding with this will probably be about 4·26 p.ct.

Dr. Lessing again refers to this when he says "In comparing these figures with the ash percentage of coals washed in the most up-to-date plants of the older type which rarely go below 6 p.ct." From the foregoing it would appear that the washing and cleaning of coals is much better than he suspects. It would be of interest to know the calorific value of the dust extracted from the coal, which the author says in combustion efficiency is at least as high as that of powdered fuel of the same ash content. With regard to carbonization tests, it was unfortunate that the retorts used could not be isolated; otherwise the results are very much the same as one would expect. This also applies to C.W.G. tests, but it is rather difficult to understand that the yield from the coke from the unclean coal was 67,872 c.ft., as against 67,648 c.ft. from the clean coke; although Dr. Lessing states that the coke used per therm was less with the clean coke. As oil was used during the tests it is not quite clear how this was arrived at; it would, perhaps, have been a better comparison if both the tests were carried out making blue water gas without the complication of the oil increment.

Price Ruled by Competing Coke.

The author has assumed that a higher price would be obtained for the coke of low ash content, and he has forestalled criticism on this point by giving figures with clean coke at the same price—which he terms the pessimistic basis. Unfortunately, the price of gas coke is not so much ruled by its quality as it is by the price and quality of coke from ovens in competition with it and also the export market. This paper is, however, a useful contribution, more especially to those who have not yet realized the value of at least the ordinary washed qualities of coal. I think we are very deeply grateful to Dr. Lessing for having given us this very interesting and scientifically conceived paper, and I hope we shall have a very interesting discussion.

Sir Arthur Duckham: I think that possibly I have lost as much money on experiments in coal cleaning as Dr. Lessing, and therefore I feel myself in a position possibly to say a few words about it. I do not think we of the Gas Industry, or, indeed, we of the fuel industries in Great Britain, have given sufficient attention to the question of coal cleaning. With the development of competition in fuel throughout the world we must rely for our export markets on the proper cleaning of coal, and, therefore, for the coal industry a proper economic coal cleaning plant is essential. Unless we prepare our coal for export we shall lose our coal markets abroad, and we shall lose that great wealth which flows into this country from the selling of coal.

With regard to the Gas Industry I think the cleaning of coal is even more important than for the coal industry. We have only one residual left from which we can hope to make any considerable profit, and that is coke, and good coke must follow good ash-clean coal. The President has spoken of some of the coals that you can buy in his district. It makes the mouths of some gas engineers water, I am certain, when they hear of the good coal he can buy and the good coke that he can make. Coal cleaning must come, and it must come rapidly. It would have come on the colliery side sooner if they had had any money to buy coal cleaning plants with, but I have never yet, at any rate recently, found anybody connected with the coal industry who has any money to buy anything with. The Gas Industry on the other side can consider coal-cleaning plants at their works, but, after all, that is the wrong place, and the Gas Industry is putting certain pressure on the collieries to supply clean coal. Going through the Durham district you see that coal cleaning plants have been installed and they are getting better prices for their coal in consequence.

An Important Problem.

With regard to Dr. Lessing and his work, we of the Gas Industry owe a deep debt of gratitude to him for the many years he has preached this subject of coal cleaning which I think to-day is one of the most important problems that we have to face. Dr. Lessing has done yeoman service and splendid technical work in the development of the process he has described. He has put a process to you in connection with which he has gone to the laboratory and to test methods by which we can ascertain the ash in the coal, and he has made these tests practical. I do not think we need say much about the possibilities of the process because undoubtedly Dr. Lessing has a process which will give you as low ash—or lower—as any other process in existence

can do. Of that there is no doubt, and the only questions which arise in connection with this process are how easily can it be worked and what are the costs of the clean coal when you have got it. Dr. Lessing has shown that it can be worked easily, and I am quite certain that the process has a very big future before it. If I might deal with one question which has been raised from time to time, it is the action of any calcium chloride that might be left in the coal going through your carbonizing plant, and the effect of it on the structure of the carbonizing plant. I feel sure that, with any reasonable care on the works, this is no longer the bogey that it was thought to be in the first case, and, therefore, Dr. Lessing has put before us a process which is an absolute process.

Therefore, the whole question comes down to one of cost of operation, but there is another thing Dr. Lessing has done in coal cleaning. He has also spoken of de-dusting, and he has shown you clearly here this morning how de-dusting is done and the benefits of it. I think that is fundamental. I think in any cleaning plant that may come in you will have to start with a de-dusting plant. I think Dr. Lessing has developed a very fine de-dusting plant, and the larger question is that of capital cost. It may be too high in price, but I know he is trying to reduce the price of his de-dusting apparatus. I am not going to criticize Dr. Lessing, however. I am very fond of him; we are all very fond of him, but I think he rather gilds the lily. As the President says, he makes your mouth water very much. He offers us the ultimate, and if we do not get the ultimate then we are dissatisfied. If he offered us half the ultimate, and we got three-quarters of it, we should be extremely pleased. I sometimes criticize Dr. Lessing in all friendliness, but I think that here is a process which does not give us the ultimate coal-cleaning process. I would not ask Dr. Lessing to tell me anything more than that. I do not want him to tell me that he can run a boiler for a month or six weeks without any clinker or ash at all. I know that with this process I shall get the least possible ash I can get on a boiler, and that is all I care about. I do not care about the very ultimate results, but I feel that here is a process which may be spoiled by expecting the ultimate, the ideal, because it is a process which must be a work-a-day process to be used every day. I think we shall thank Dr. Lessing very heartily for the work he has done and the Institution for arranging for this paper to be read.

De-Dusting.

Mr. H. C. Smith (Tottenham and District Gas Company): I have always listened with great interest to anything Dr. Lessing has to say about coal cleaning, but I never realized until I had an opportunity of carrying out investigation with him on a few hundred tons of coal which had been cleaned on his plant what a difference there was between the coal cleaned on this plant and the coal which is ordinarily supplied to gas undertakings as cleaned coal—containing anything from 5 p.ct. of ash upwards. Undoubtedly the preliminary treatment by de-dusting is largely responsible not only for the cleanliness and efficient working of the plant itself but also for the excellence of the coke produced after carbonization.

To one who has seen other coal cleaning plants at work an inspection of Dr. Lessing's plant is a revelation. It is quite possible to walk about the plant while the coal cleaning process is in operation without getting covered with coal dust, and what is perhaps more remarkable is that the drainings from the coal after it has been cleaned are clean enough to discharge into a drainage ditch or sewer without further treatment. Dr. Lessing has referred to some numerical data which I gave in a recent Address to the Southern Association as a result of the investigation at Tottenham, and he has also amplified the data by additional figures.

It was very interesting to find that the moisture content in the uncleaned coal was 4·27 p.ct., and that this had only increased to 4·34 p.ct. in the clean coal. One generally would expect to find the percentage of moisture increasing after coal had been cleaned by a wet process. No doubt the fact that the moisture percentage remains practically the same is again due to the removal of the dust which leaves the coal in such a condition that it drains very easily. The reduction in the percentage of breeze made is also due to the same cause, the yield of breeze in the coke from the cleaned coal being 7·5 p.ct. containing 3·63 p.ct. of ash, as against 14·9 p.ct. containing 25·78 p.ct. of ash in the coke from the uncleaned coal. There was very little difference between the ash percentage in the various grades of coke made from the clean coal, whereas in the coke made from the uncleaned coal the ash increased from 7·91 p.ct. in the large coke to 25·78 p.ct. in the breeze. Clean breeze should certainly not be regarded as low-grade fuel. If I might ask the President a question, I should be interested to hear whether the ash figures which he gives in his coke applied only to the large coke or whether they were on coke of all sizes and grades including the breeze.

The President: Yes; they applied to all grades.

Mr. Smith: The length of time which it was possible to work a water gas generator without clinkering provided a very good practical demonstration of the effect of using clean coal. It was possible to work the generator for two days without clinkering. To leave the generator for 48 hours was longer than would be advisable under regular working conditions, but it would be quite economical and practicable with such fuel to clinker only once every 24 hours. I am not in entire agreement with Dr. Lessing on the statement of costs which he presents at the end of his paper.

A Remarkably Low Figure.

Following Table 4 a figure of 5d. per ton is given for cleaning coal. This seems to me to be remarkably low. A figure of 10s. per ton is taken as a credit for the disposal of the dust. I think this dust will be difficult to dispose of. It certainly—as Dr. Lessing on previous occasions has stated—will require special wagons, and while it may be mechanically suitable for use in pulverized fuel burners, whether it will be attractive, considering its high ash content, is in my view open to doubt. No credit is taken for refuse, and certainly no credit should be taken. I think there would be a charge here for the disposal of refuse, and in making such estimates it would be safer to set off any revenue from dust against the cost of disposal of the refuse.

In Table 6 Dr. Lessing takes credit for lower carbonizing wages and lower costs of maintenance and repairs in the case of clean coal. I doubt whether these lower costs would really be attainable in actual practice—at any rate on existing plants. When building new carbonizing plant to carbonize clean coal and nothing else, it might be feasible to put in a slightly smaller plant and arrange for less labour; but because clean coal is brought on to an existing plant I do not see that carbonizing wages and maintenance and repair costs are necessarily to be lower. More gas could undoubtedly be made on that particular plant, but that does not mean to say that more gas could necessarily be sold.

On the revenue side of that table credit is taken for clean large coke at 26s. 5d. per ton, against 24s. for large uncleaned coke. Undoubtedly, the clean coke is worth more than the coke made from uncleaned coal, but it will take some little time to persuade coke customers that this is a fact. Against this increased value of coke on account of its quality is the fact that the coke made from the cleaned coal contains a greater proportion of the larger sizes with reduced proportion of the smaller sizes; and many undertakings—at any rate in the South of England where sales of graded coke have been developed—have found that the smaller sizes command a higher price than the large. The coke made from the clean coal is hard, and in order to satisfy the demand for the smaller sizes it must be cut at considerable expense.

These are only minor criticisms, and I should not like them to be taken to mean that I am not strongly in favour of doing everything possible to encourage the cleaning of coal—particularly by Dr. Lessing's or any other method which will clean coal as thoroughly without replacing the ash removed by a corresponding weight of water.

Dr. E. W. Smith: I should like to take this opportunity of stating that in the discussion in which I took part the other day I believe I used an expression which might conceivably be considered to be a reflection on the writer of the paper. If that is so, I very much regret it.

As regards Dr. Lessing's paper, there is no subject in the Gas Industry which is of more paramount importance, whether it be to the costs on the works or to the returns from the products obtained by the gas undertaking, than coal cleaning. Dr. Lessing has laid very considerable importance on producing a coke which the housewife will accept with greater enthusiasm. I do not think the Gas Industry as a whole will have a smooth time until it is capable of producing consistently, from large works and small works, a coke which is equally as good as the normal coke available from the coking industry, and we have to accept it that the coking industry is capable of producing and does produce a coke which is much lower in ash and very often lower in moisture than some of the coke—not by any means the bulk of it, but some of the coke—that is available from the Gas Industry. At the same time, Dr. Lessing rather suggests that everything has gone forward well in the Gas Industry and that there has been advance in every direction with the exception of the matter of coke.

A Demand for Washed Coals.

With my limited experience of what is going on in the Gas Industry, I should say that there is no subject that during the last five years has received more attention, nor

indeed in which greater progress has been made, than in the preparation and production of coke. One has only to go round and see the coke that is available for the domestic consumer, to see the trucks on the railway wherever you go, to see not only distinct signs but remarkable evidence of well graded, well carbonized, lower moisture, and even lower ash coke. That is because in a very big way many gas undertakings are demanding washed coals. Some collieries are in trouble to-day because the demand for coal from these collieries has been switched over to collieries which are capable of giving low ash coals or coals which have been washed, so that for the credit of the Industry I should like to make the point that a tremendous advance has been made. But a lot more needs to be done if coal cleaning is to be carried out, as it must be, at the collieries. It is not the slightest use the Gas Light and Coke Company or the South Metropolitan Gas Company or the Birmingham Gas Department going to a large expense to wash their coals to produce a good coke if someone else near to them is producing a bad coke and spoiling the market, because one bad sale completely neutralizes 100 good sales. Therefore the coal cleaning will have to be done at the collieries, and then we want a process such as Dr. Lessing has described.

I am glad Sir Arthur Duckham has drawn attention to the fact that Dr. Lessing rather overdraws the bow. He has a wonderful process without exaggeration, and he is rather claiming too much. He is claiming unnecessary things; when he, as a scientific man, puts forward these tests for making water gas and claims an advantage for making water gas from clean coal, he only gives evidence of an unnecessary exaggeration. It must be that a low-ash coke would be of enormous advantage in the production of water gas, but any of you who are making water gas know that if you use 1½ gallons of oil you can make a 450 B.Th.U. gas, within a few B.Th.U. Figures I have seen from many works indicate that to be the case, and when Dr. Lessing, from what must have been a very short test, gives a figure of 429 B.Th.U., as the normal practice, I suggest he is not stating what is the normal practice. That result must have been obtained from a very short test, and I suggest that it be withdrawn because it does not represent the Industry's normal practice.

Another big advantage of cleaner coke is that, as Dr. Lessing recognizes, high ash coke used in producers on carbonizing plants means that there will be increased trouble with ash in the combustion flues and in the distribution flues of the carbonizing plant. That means you are limited in the temperatures that you can run at; there will be stoppages for cleaning out the ash from the flues, &c. If the fine ash is taken out of the coal and the better form of ash is left in the coke, there will be less ash in the settings and they can continue in operation for many months longer, without being cleaned. If Scotch coal could be cleaned down to a reasonable figure it would make a great deal of difference in Scotland. I have checked up this question of the danger of the chlorine being left in the coal. I think it will be accepted that when the chlorine together with what is in the coal as chlorine is less than 0·017 p.ct., there is 100 p.ct. safety, and that there will be no trouble whatever with the refractories. That has been checked up, and the chlorine is invariably, in normal working, brought down to less than 0·017 p.ct., so that there need be no worry on that score. I do not think I have anything else to say except to recognize Dr. Lessing as practically the pioneer in constructive effort for reducing the ash in coal, and more power to his elbow.

On Behalf of the Coal Industry.

Dr. F. S. Sinnatt: I think it should be my job this morning to take up the cudgels of the coal industry from this point of view—that I have before me some statistics of the amount of coal that is cleaned in the country by the coal industry. These have been prepared by the Mines Department and they relate to three years. They are very instructive. In the first place, Mr. Mitten in 1924 tried to get an idea of the amount of coal that was cleaned in the country, and he obtained a figure of something like 25 million tons. In 1927 the Mines Department commenced to publish statistics of the coal cleaned, and the first figure they give is 51 million tons, or 20 p.ct. of the coal raised. In 1928 the figure was 60 million tons, and in 1929 it was 71 million tons, or 27 p.ct. of the total coal raised. I think it will be agreed that these figures are very considerable and especially when you remember that it is only certain sizes of coal that lend themselves to washing—shall we say coal below 3 in. or 4 in.—and, consequently, this percentage of 27 p.ct. might be nearly doubled when you take into account the amount of coal that is suitable for washing. Therefore, I just want to put it to you as a generalization that combined with the immensely important work done by Dr. Lessing, the coal industry itself is making a real endeavour to place at the disposal of the Gas Industry as much pure coal as can be obtained. I think 71 million tons per annum cleaned in various kinds of plant is a very fine ugure. That was in 1929.

The next point I want to refer to is that Dr. Lessing has spoken of coal containing 1·6 p.ct. of ash. Just have that in mind and think of it in terms of the coal seam from which it was obtained. That seam must have been extraordinarily pure, and in connection with the survey which we are carrying out of the coal seams of the country, we have examined something like 35 seams systematically throughout the various coal fields, and the figures are something like this. It is very rare—say, one in six or one in seven—that the seam from top to bottom contains much more than 6 p.ct. of ash, and the largest proportion of the coal seams contain from 3 to 4 p.ct. of ash. The result is that with Dr. Lessing's process you can say that that coal is pure. It is possible to obtain coal in the state of purity that he is trying to obtain—*i.e.*, the impurities that are found associated with coal are not in the seams themselves but are introduced afterwards.

The next point that struck me in reading the paper is that I think Dr. Smith has made a very important point when he spoke of the coke that is produced by the coke oven industry, because in connection with every modern coke oven plant there seems to be a modern washery. As part of the equipment you have a washery of some kind, and, consequently, it appears to me that you have to face a very distinct competition from that quarter. Coke made from purified coal is being put on the market as a competitor with your product.

On the technical side I am extremely interested in Dr. Lessing's de-dusting plant. Here I think he has put his finger on a most important factor—*i.e.*, the removal of dust prior to washing. That is one of the most important parts of his work; I am not saying that the other part is not important, of course. I am making the generalization that if every washery that is trying to be efficient would first remove the dust it would improve their process. Consequently, we have the two important sides to this matter. One is the washing and the other is the de-dusting. Dr. Lessing has mentioned some tests that have been made at the Fuel Research Station upon the coke, and we certainly have found that the coke prepared by this process is very good indeed. There is no doubt about that, although I will not say that it is better than anything else; but it is very good indeed.

Intangible Advantages.

Mr. L. H. Sensicle: The many advantages of clean coal for gas making are largely of the intangible character that defies statistical and monetary evaluation. Dr. Lessing has done more than most in furthering the adoption of coal cleaning, but I would like to suggest that in attempting to give a monetary expression to the advantages he has almost inevitably put an insufficiently convincing case. There seems in fact to be some uncertainty in the basis of the calculations.

In the third section of Table V. uncleaned coal with an ash content of 9·05 p.ct. is justifiably assumed to yield 72 therms per ton; but after cleaning it is assumed that 72 therms will be obtained from only 0·903 ton—that is to say, 79·7 therms per ton of cleaned coal. This is contrary to the results of a number of experiments with which I was connected a few years ago. In actual horizontal retort practice coal containing 9 p.ct. ash often yields more than 72 therms per ton; but can Dr. Lessing cite any case where nearly 80 therms of "straight" gas per ton have been obtained as a result of cleaning such a coal?

On the basis of such an assumed yield Table VII. shows a saving of 1s. 1·6d. in favour of cleaned coal, but the following statement occurs later: "The question of allocation of the saving has been disregarded. Some of it the colliery will claim in respect of recompense for the enterprise of putting down and operating the cleaning plant. . . ." Evidently this hypothetical saving of 1s. 1·6d. per ton of coal cleaned is to be shared between the gas and colliery companies, and the proposition is not enormously attractive when expressed in this way.

As a firm believer in the advantages of clean coal I would suggest that to assess their financial value—if this must be done—it is necessary to study the matter in much fuller detail. Thus among the losses due to the use of dirty coal would be increased fuel consumption, increased labour in clinkering producers and general cleaning of plant and works, increased power consumption of coal and coke-handling plant, decreased life of refractory material, producer grates, &c. Most of these items would be difficult to assess, though one might be convinced of their existence and importance. In conclusion, I would suggest that without troubling to express in figures the advantage of clean coal for gas-making, an all-sufficient reason for its adoption should be the production of a clean coke which can compete

successfully with other prepared fuels in the domestic market.

Mr. T. Law (Malton): The question of clean coal is one in which I am very interested, and Dr. Lessing has dealt with it in a way with his great knowledge of the subject which will make gas engineers think more about the great advantages one derives from using this class of fuel. I am in absolute accord with him when he says that it seems obvious that the value of the coal for coke making is of the utmost importance.

A Great Step Forward.

His description of the cleaning of the coal by the calcium chloride method is very interesting and is certainly a great advance on the water method, and when the greatly reduced moisture content is noted, it must be admitted a great step forward has been taken in the production of clean coal. I believe that one of the reasons why more gas engineers do not use washed coal is because of the moisture content. He has shown us that it pays to use clean coal, and I am with him all the way, for I will not use anything else but washed coal, only in cases of necessity, such as strike times, and then one is thankful for any sort of coal which has gas tacked on to it.

In Table VI. (Expenditure and Revenue A/C.) I think Dr. Lessing has been very conservative in only allowing so little extra revenue for coke made from clean coal, because I can get at least 3s. to 4s. per ton more for mine than if I used uncleaned coal. A coal agent to whom I sell my surplus coke when I have any would always buy from me if he could get it, but fortunately for me and unfortunately for him, he cannot always get it. Why I say fortunately for me is that I should have to sacrifice something on the yard price if I sold to him. As he must keep his customers supplied, he of necessity has to buy elsewhere, and he has told me personally (although he buys coke from both gas-works and coke ovens) that he would rather buy from me at a higher price, as he then gives satisfaction to his customers and has no further worry. When I asked why, he informed me that the coke did not clinker so much, and it needed less attention.

I have tried coal which has not been washed and guaranteed by the colliery concerned to be as good, but when I have carbonized this class of coal the yield of gas has generally been about 10 p.ct. less than when using coal properly washed, which tends to bear out what Dr. Lessing says in his paper—that 0·903 ton of clean coal will yield as much gas as a ton of uncleaned coal. I will not, in a general way, entertain any coal with more than 3 p.ct. of ash, because I am convinced that on an 85-million works (I will not call it a small works) it does not pay. If stokers have to attend to the producer fires they are liable to be neglected if the original coal contains a high percentage of ash, with resultant loss of heat and reduced make of gas.

If the difference in price between uncleaned and cleaned coal is as much as 2s. per ton, and it is possible as I have done, to get 10 p.ct. more gas from the clean coal, or 7 therms at 8½d. per therm, then it pays to use clean coal for its gas producing qualities alone. In addition to the increase in gas make, there is time saved in attending to the producer fires, less ashes to remove from the ashpans, and, consequently, less to cart away from the works, less wear and tear on the settings, and, what is very important, a gas coke of high quality which will ignite easily and not die out, and leave very little refuse for the user to remove.

I endeavour to supply this high quality coke from washed coal, and as I stated in a paper recently, I fully believe it is due to the quality of the coke that the demand exceeds the supply shortly after Christmas. You cannot get clean coke unless you use clean coal. I have had customers call upon me and tell me the price I am asking for coke is too much, and that they could buy very much cheaper. In some cases they have tried the cheap coke and paid dearly for their experience, due to the fact that it would not burn without a great deal of attention, and often went out during the night. This, especially to a nursery man who complained about the high price and tried the so-called cheap coke, was a serious matter, and it has invariably meant that after trying it, they have returned and been the most loyal customers afterwards.

Specific Cases.

Not long ago a gentleman removed from one of the neighbouring villages into Malton. He had always bought his coke from the coal agent, and while living in the country had found it quite satisfactory. He bought a supply for his new house, lit the boiler up and found that the water would not heat. A heating engineer was sent for, but after examining the installation he could not find anything wrong, and he advised, to use his own words, the use of gas house coke. Some coke was sent for, and within two hours of using the gas-works coke there was an abundance of hot water, and I have since heard from the coal agent who previously supplied the coke that the gentleman had informed him it was the best coke he had tried, and he would continue to use it, although he was paying a much higher price per ton than what he had previously paid. About a year ago a gas consumer bought an anthracite stove and started to use anthracite, which was not satisfactory. He was advised by the firm who supplied the stove to try the local gas coke, which he did and found it quite satisfactory.

It might interest you to know that the sum spent by my Company on coal and oil last year was £7372, and the receipts for coke amounted to £3813, or nearly 52 p.ct. expended on coal was received back for coke. Perhaps I am in a fortunate position for the disposal of coke, and I give you the figures for what they are worth; but at the same time I fully believe the use of washed coal is mainly responsible for such a good revenue.

We must all concur with Dr. Lessing where he says that the first and foremost condition of good service is the meticulous care with which the quality of gas, its freedom from impurities, and the constancy of supply is controlled and maintained. The next consideration should be the production of a first-class coke, and only on the lines of Dr. Lessing's paper in his advocacy of clean coal for gas-making purposes can we hope to bring this about, and make a fuel which will not be a drug on the market but will find a ready sale. I wish to express to Dr. Lessing my personal thanks for a most interesting and instructive paper.

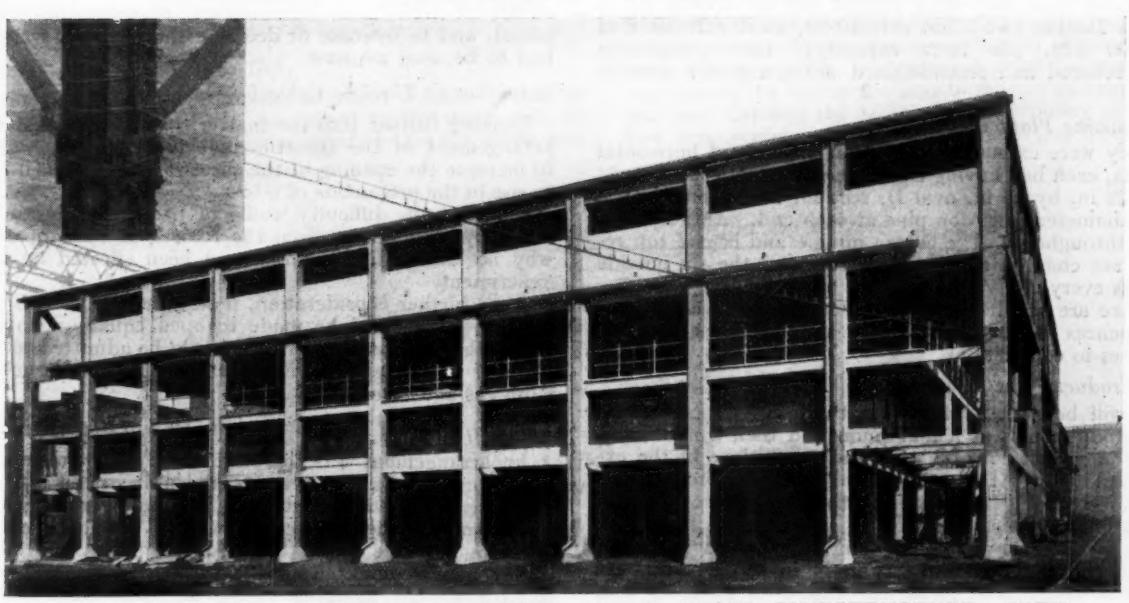
Mr. W. B. McLusky (Halifax): My observations are mainly in support of Dr. Lessing. I should not presume for a moment to criticize anything he said, but if I said he was right in everything he said you would probably say to me, "What do you know about it?" [Laughter.] I would, therefore, like to deal with one or two matters discussed in the paper. It is seen from the figures given in the paper that the ash in the breeze from the uncleaned coal is 28·78 p.ct. and the ash in the breeze from the cleaned coal is only 3·13 p.ct. We as practical men who work in the retort houses know that that is where the ash is, in the small pieces especially if you are carbonizing your coal in a continuous vertical retort. You also know that while your coal may be very clean on the average that is of no value whatever, because a small piece of impurity makes the coke unsaleable. Therefore the average ash content of the coal is of no interest to me. If there is any foreign matter in the wagon we are bound to get it in the coal. When the coal is purged of these impurities the solid fuel which we call smokeless fuel—*i.e.*, coke—is purer than the raw material from which the coke was made, however free the coal may be from extraneous matter. With modern plants it is less difficult than formerly to produce gas of uniform quality, but without clean coal even the most efficient gas-making plant will not do its best work. It is an extravagant thing to waste good time and money on dirty coal. If it is inherent dirt or not it will make the coal useless. The blending of good, clean coals is necessary in order to produce a smokeless fuel suitable for use in parlour grates, kitchen ranges, central-heating boilers, and for general industrial purposes. One cubic inch of foreign matter would not influence the day's work in a baker's oven, but a single piece of foreign matter will spoil a welding heat or waste a rivet. Coming down to the commercial basis, we find in practice that careful blending not only improves the reactivity of the customer's fire but reduces the weight of the breeze. In Halifax we have to crush the large coke to get a sufficient tonnage of nuts which we sell in the four sizes—½ in., ¾ in., 1¼ in., and 1½ in. The total volume of dust resulting from the carbonizing of the coal and the grading of the coke is not more than 5 p.ct., and 130 shopkeepers in Halifax are selling our fuel over the counter.

Dr. R. Lessing replying to the discussion said: I do not wish for one moment to encroach on your time, because there is another paper to come, and I would not like to be accused of crowding it out, having had other "accusations" levelled against me already. In the first instance, however, I would like to say this: The President has given us from his own experience at Hull figures which are certainly very remarkable indeed. All I can say is that they only show what the state of affairs must be if the average, as produced normally, is quite different from what he gives us. It simply shows that you have been fully justified in your choice in having him to guide the affairs of the Institution for a year, which he undoubtedly has done as efficiently as he carries out his duties in managing his works, because these figures must be the lowest for any big works that have come to my knowledge. They certainly do not represent the average of to-day's working. On the other hand, it is a step in the right direction, and I do not think it will be very long before we reach this or even get lower still, although there is very little to spare.

There will not be time to go into the various details of

the discussion, and perhaps I may be permitted to reply in writing to some of the individual points on the technical side, and particularly on the economic side, that have been criticized. What I would like to make quite clear is this. I have been accused of gilding the lily. On the other hand, there was a certain amount of consensus of praise which has made another lily blush, and between the two I am not quite certain what to say. If I am really gilding the lily and have over-stated my case, I certainly have not done so intentionally as regards the process and I am quite sure that neither Sir Arthur Duckham nor Dr. Smith nor Mr. H. C. Smith, who referred to that question, had that in mind. If I do stress points they are points attaching to the product and not to the process. I do not say other washing processes would not yield coal as clean as this, but they could only do so by sacrificing yield and consequently raising the price of the washed product, but from my experience, as one who has been trying to look ahead a little, it is necessary to tell you all that is possible, and I believe that in a very few years what I have stated will be found to be true in fact, although perhaps to-day seeming a little exaggerated. I see personally very clearly indeed that very much can be done with comparatively little effort in improving these matters, and when I speak of the clean faces of the stokers I am absolutely serious about it. I do say, moreover, that with this kind of material, without the absolutely unnecessary impurities which are going into the carbonizing plants in gas-works to-day, it would be possible to obtain a totally different kind of product. On the question of the price to be obtained for the product, I must break a lance with all those who say that they cannot get more for the clean coke than for the other. I have said so in the paper, and I cannot help feeling that they regard themselves as worse salesmen than they in fact are, if this is so. It would be absolutely incongruous if you should be asked to pay 1s. 10d. more per ton for the clean coal to the colliery on account of cleaning costs and the loss of inerts, while on the other hand, you should not be entitled to get the same amount from your customers who would have very much greater benefits than you, as the converter of the raw material into this better class product. It simply will not go into my head that that is so, but even if it is, one fact is certain, and Mr. Sensicle and others have mentioned it—namely, that you will be able to sell every ounce of this better class coke where the ordinary kind of coke would be a drug on the market, and it is from that point of view that you have to look at it. Once a consumer has real knowledge of what he can do with a coke, he will pay anything for it, as most of them do now, and certainly I believe the domestic consumer. I do not want to go into a discussion of seasonal changes, but there may be more difference in the price in winter and in summer than would be necessary in order to make the balance-sheet right. On the question of the balance-sheet, that is based on certain tests, and I think I ought to say at once—partly to defend Mr. Smith himself, who very kindly carried out the tests and has done so much in assisting to get any results at all—that I was faced with the alternative of giving a general discourse on coal cleaning, which I have done on many occasions, and I have been sometimes ridiculed for the persistence with which I have done it, or else to give you some sort of basis as a foundation of my argument. The only basis which I had was not tests of a laboratory kind but large scale tests which certainly satisfied me very much more than my own tests ever have done before. Therefore, the dilemma was either to give you nothing or what I did. I decided to give you the available figures. These were put before you with all the provisos required, and I hope nobody will run away with the idea that the figures in respect of the unclean coal or the clean coal represent any more than they do—namely, the results of tests on a few hundred tons of coal. We all know to-day that we have to go not only on a week's test but a year's test or even longer periods, and I hope that will be done in practice. The balance-sheet based on these tests has been drawn up to my best knowledge and belief, and all the figures which were available have been used. Of course, certain assumptions had to be made, but again the grounds for these are given, and I should be very glad to give full details of the calculations. Even assuming for the moment that there is no credit balance left—and I never expected there would be an actual profit when I started on all this—the improvement of the product which you are able to put on the market will justify this as being a step in the right direction. Even in these circumstances my case is a good one. I think I cannot go any longer into details, and if you will allow me I will deal with the other points in writing. I should like to thank you for the very kind, patient hearing you have given me, and I am afraid I shall have to be pardoned for extending the paper as much as I have done.

CAST IRON PURIFIERS



14–35-FT. SQR. PURIFIERS ERECTED UPON STEEL SUBSTRUCTURE WITH REVIVIFYING FLOORS BOTH ABOVE AND BELOW.

THE STEEL MEMBERS WERE WIRE WRAPPED (AS SHOWN IN SMALL ILLUSTRATION) AFTERWARDS BEING CASED IN CONCRETE.

R. & J. DEMPSTER, LTD., MANCHESTER.

LONDON OFFICE: 34, VICTORIA STREET, WESTMINSTER, S.W.1.

An Experiment in Controlling Pressure Conditions within Coal-Gas Retorts

By R. N. WEBB, M.Inst.Gas E.,
Leeds Corporation Gas Department.

I think all concerned in the industry of coal gas manufacture will agree that the competition we are now faced with in the selling of our products is more severe than ever before. It is therefore very necessary that we do everything possible to improve continually the results we obtain from the carbonizing plants under our control to enable the products to be sold at a competitive price.

It does not matter how small the improvement may appear to be; it is essential that it be brought about. It often happens that what at first appears to be of little importance develops into a matter of very great importance if thoroughly investigated.

In this category, I think, can be placed the subject matter of this paper. In the Leeds Gas Department, we commenced our experiments hoping, if they were successful, to reduce our retort house troubles. I am happy to say that we have accomplished this, and in addition we have benefited in other ways which were not originally in our minds.

We all know that it is necessary to use exhausting machinery to remove the gas from the retorts as quickly as it is produced, but are we all sure that we are using it correctly? We have all experienced retort house difficulties that have eluded us and which we have suffered as being inherent in the system, when, had we probed them we should probably have found their cause.

It is my opinion that the misuse of exhausting machinery, very often not knowingly, is the principal cause of these difficulties; it was because we had been baffled by them that we commenced the work which has given rise to this paper.

Type of Exhauster in Use.

In proceeding to describe the experiments, it should be stated that they were carried out on a twin set of Bryan Donkin two-blade exhausters, each exhauster of 100,000 c.ft. per hour capacity; these exhausters were rebored and reconditioned about eighteen months ago.

Carbonizing Plant in Operation.

They were exhausting gas from 22 beds of horizontal retorts, each bed having eight fireclay retorts set 3, 3, 2; of a 22 in. by 16 in. oval D. section, 20 ft. long with a 6 in. diameter ascension pipe at each end. Anti-dips are used throughout. The centre middle and centre top retorts are charged every eight hours and the six outside retorts every twelve hours.

There are six draws per eight hours shift; each draw commences at 80 minutes intervals and takes 50 to 55 minutes to complete.

Gas Production at Maximum and Minimum.

It will be seen by this that there are periods where gas production is at a maximum and then a minimum, and the correct controlling of the revolutions of the exhausters to suit these conditions was the problem we faced. I should remark here that we do not employ retort house governors.

We were of the opinion that if the conditions prevailing in the common foul gas main in the retort house could be reproduced inside the exhauster governor-bell, the varying pressures would act on the bell and operate the steam throttle-valve accordingly.

We therefore connected the foul gas main to the bell with a 3 in. diameter pipe which will be spoken of throughout as the impulse-pipe.

Type of Governor in Use.

We had in use on this exhausting set one of Messrs. Waller's latest type of governor, the bell, 16 in. diameter, being fitted with a loose float and supported over two pulleys by small diameter wire ropes and balanced by weights, a 2 in. throttle-valve with the regulating lever fixed to its spindle and actuated by the rise and fall of the bell in the tank in the usual way [see Fig. 1]. The 3 in. impulse-pipe was reduced to $1\frac{1}{4}$ in. diameter at the inlet to the bell, replacing the maker's 1 in. diameter pipe.

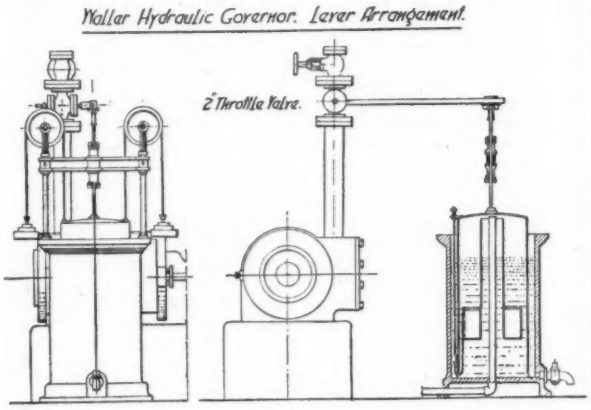


FIG. 1.

Originally this 1 in. diameter pipe to the interior of the bell was connected to a 2 in. pipe, which in turn was connected to the 24 in. diameter foul-gas main about 50 ft. away from the exhauster inlet.

On setting the new impulse-pipe arrangement to work, no difference whatever was noticed on the vacuum recorder on the inlet to exhausters to that previously obtained, and to increase or decrease the vacuum, weights had to be used as usual.

Actuation of Throttle-Valve by Governor Bell.

Looking further into the matter, it was seen that the arrangement of the throttle-valve lever was such that to increase the opening of the throttle valve the bell had to rise in the proportion of 8 to 1.

Realizing the difficulty would be to get the bell to lift at all by the impulse from the retorts, it was apparent why no change in governing had been effected by this experiment.

After further consideration, it was thought that if the throttle-valve could be made to open equally with the rise of the bell, sufficient steam would be admitted to the cylinder to speed up the engine to account for the maximum gas and *vice-versa*.

Equal Opening of Throttle-Valve to Rise of Governor Bell.

An arrangement was therefore made which dispensed with the usual balance weights and pulleys and allowed the bell to be suspended from the centre rod over a pulley and attached by means of a small diameter flexible wire rope to one pulley of a double pulley, the other pulley being connected to the throttle-valve lever and counterbalanced, as shown by Fig. 2. These three pulleys are all of the same diameter.

When this arrangement was put into action, an improvement was quickly noticed, inasmuch that the throttle-valve responded quicker to the action of the bell.

Ratio of Opening of Throttle-Valve to Rise of Bell made 4 to 1.

It soon became evident, however, that the throttle-valve was not actuating quickly enough, and it was decided to increase the ratio to 4 to 1—*i.e.*, the valve to

open four times the lift of the bell. In making this alteration, ball bearings were used, which very considerably reduced friction.

This second arrangement was again an improvement, and responded still more easily and readily to the weighting.

Waller Hydraulic Governor. Equal Pulley Arrangement

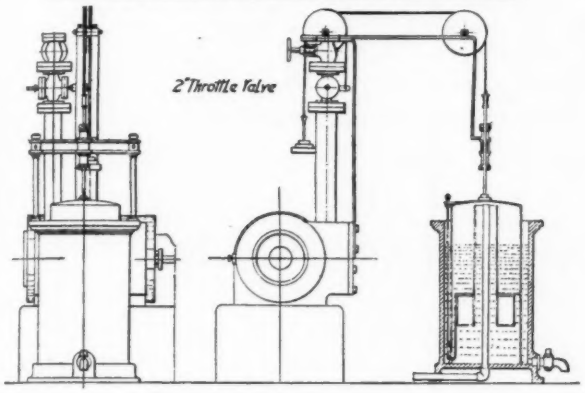


FIG. 2.

Ratio of Opening Increased to 8 *to* 1.

A further alteration was made and the proportion increased to 8 to 1. The proportions were obtained by having a small pulley, $1\frac{1}{4}$ in. diameter, with a flange which was fastened to a larger pulley of a sufficient diameter to give the ratio desired, the small pulley always being connected to the bell; Fig. 3.

Sluggishness of Governor Bell.

When this arrangement was set to work, it was noticed that very little change had been effected, and for some time we were rather at a loss to account for it. Sluggishness was the fault which we eventually attributed to the float inside the bell; the loose float was removed and the water level in the tank lowered below the partition, leaving the bell suspended from the pulley. The improvement in the working was remarkable and the sensitivity so increased that we now got oscillation of the bell.

Oscillation of Governor Bell.

Knowing that the oscillation could not be caused by retort house conditions, we looked to the steam side of the apparatus and were soon satisfied that the cause was due to the working of the engine slide valve. I must admit that this caused us consternation, and at first seemed to preclude any further improvement. However, we continued to work for some days as we were, and to our satisfaction we found that it did not prove such a detriment as had been feared.

Simultaneous Recording of Pressure Registers.

Up to the commencement of this last experiment we had worked to the recording vacuum gauge in the exhauster house, which is an ordinary Thorpe recorder reading in tenths of an inch, but as we desired to know what was simultaneously occurring in the retort house, we installed a new Arkon recording gauge, with a magnified scale of 10 to 1, for this purpose in the exhauster house, and connected it to the 3 in. diameter impulse-pipe. We already had a recording gauge (Wright's Micromanograph) in the retort house, with a magnified scale of 4 to 1, connected to the foul-gas main, and although these two gauges are 600 ft. from each other, they show equal changes of pressure simultaneously.

Our ambition was to be able to work with a constant small pressure in the mouthpieces of the retorts regardless of the fluctuating quantity of gas being produced. Being now able to see instantaneously on the new recorder what those conditions were, it only needed the changing of weights at the governor to effect this to a more or less satisfactory degree.

Ratio of Opening Increased to 16 *to* 1.

However, as the changing of weights was required very frequently, we decided to increase the ratio of the lifts of the throttle valve to governor bell to 16 to 1. This increased both the sensitivity and the oscillation, the latter so much that we came to the conclusion that the throttle-valve (2 in.) was too large. We had noticed that it was working in a position which was so nearly closed that it was probable that the oscillations did momentarily shut it off. We replaced it by a $1\frac{1}{4}$ in. similar valve which works in a wider open position and is not in danger of being closed by the oscillations.

There was an undoubted improvement again with the 16 to 1 ratio, and the possibility of the controlling being done automatically now presented itself. As every increase of the ratio of valve opening to lift of bell had been attended with beneficial results, it was decided to make a very considerable increase to 30 to 1.

Ratio of Opening Increased to 30 *to* 1.

Instead of making a further pulley to obtain this, we made a boss in which we housed the ball bearing, drilled and tapped the rim of the boss to receive an arm at each side and fastened the $1\frac{1}{4}$ in. diameter pulley to it; this new arrangement allows us to extend the arms to any

Waller Hydraulic Governor 8 to 1 Ratio Arrangement

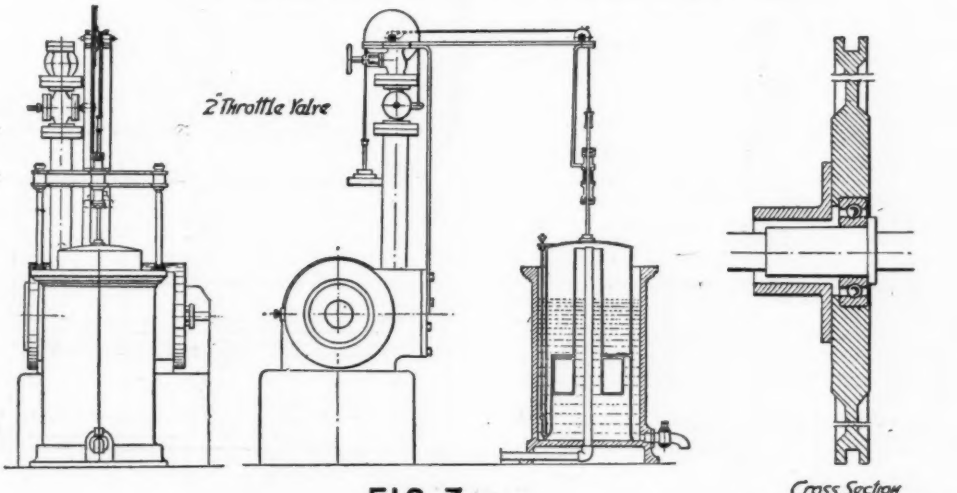


FIG. 3.

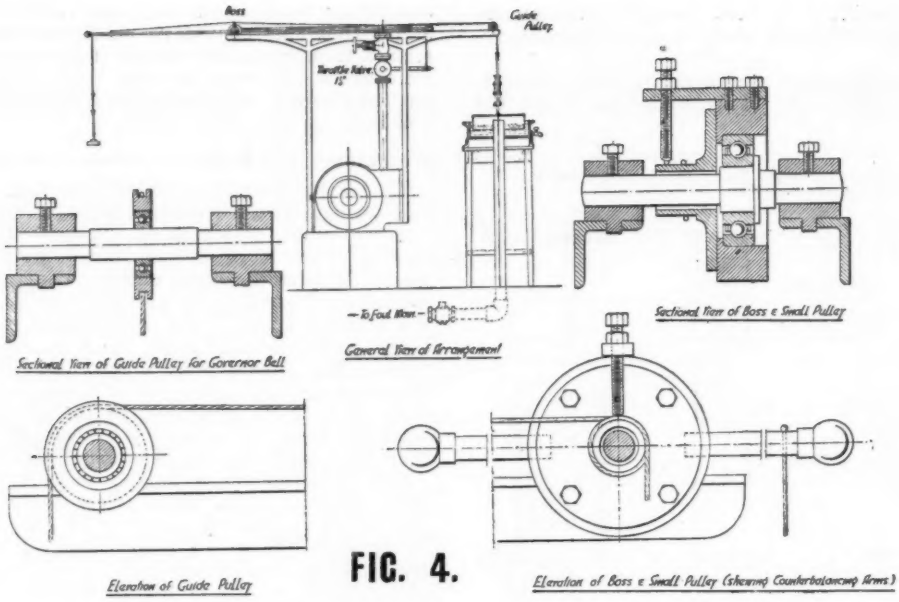

Boss
Guide Pulley
Throttle Valve
To Foul Main
Sectional View of Guide Pulley for Governor Bell
General View of Arrangement
Sectional View of Boss & Small Pulley
Elevation of Guide Pulley
Elevation of Boss & Small Pulley (showing Counterbalancing Arms)

FIG. 4.

extent and obtain the ratio desired, the whole being kept rigid by means of a tension wire; Fig. 4.

Replacement of Governor Bell.

When put into action it was noticed that the movement of the bell was still sluggish, so we decided to remove the original Waller bell and replace it with one of sheet copper; this was made much shorter, without an air chamber, and was therefore much lighter; Fig. 5. Having had it amply proved that friction must be cut down to a minimum, we had the bell made without a strengthening wire round the bottom edge, leaving only the thickness of the sheet copper to cleave the water; sluggishness was thus greatly decreased.

Much to our satisfaction, we were now able to leave the bell unattended for some minutes, and the desideratum of automatic control was brought considerably nearer.

Ratio of Opening Increased to 70 to 1.

Our experiment was continued by further increases of ratio till we reached the present ratio of 70 to 1. Now by the manipulation of very small weights on three or four occasions during a draw we are able to maintain the pressure shown on the retort house register between zero and ·4 of a tenth. It should be here pointed out that the height of the recording pen on this register is that of the centre middle retorts.

Possibility of Automatic Control.

We have not yet reached that desirable stage of automatic control, but feel confident that we shall eventually do so.

Variation of Vacuum at Exhauster Inlet.

To enable the improvements we have made in control to be more fully appreciated, I might refer to the remarks that were made earlier in the paper regarding the maximum and minimum periods of gas production. It will perhaps be of interest to know that during these periods the vacuum at the inlet to the exhausters varies over a range of six or seven tenths, increasing slowly whilst the retorts are being charged and then decreasing slowly as the time for the next draw approaches. The appearance of the record on the inlet exhauster chart over 24 hours working somewhat resembles the teeth of a very coarse saw; Fig. 6.

It will be seen, therefore, that the impulse obtained from the inside of the retorts is applied instantaneously to the inside of the governor bell *via* the impulse-pipe, increasing or decreasing the speed of the exhausters to suit the existing conditions by operating the throttle-

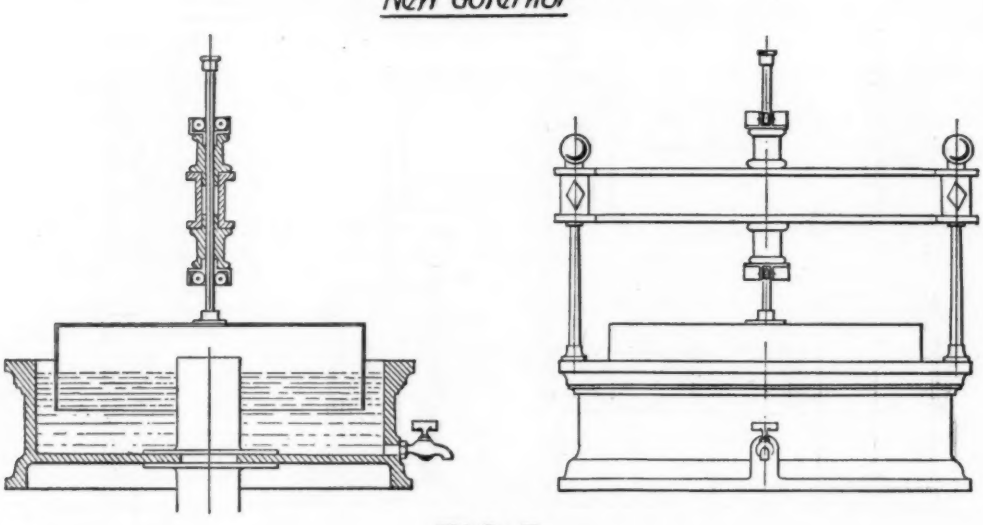


FIG. 5.

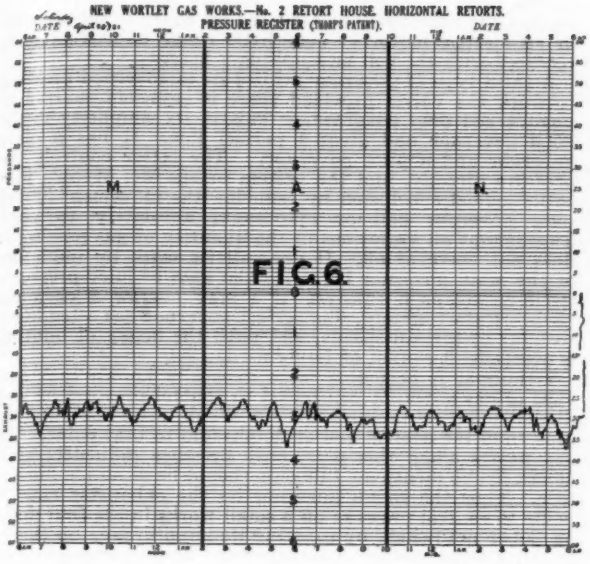


FIG. 6.

valve through the magnified ratio mechanism, meanwhile keeping a slight pressure on the inside of the retort mouthpieces (Fig. 7), each and every retort having practically the same pressure at whatever stage of carbonization the charge is.

Having got to the end of the description of the progressive trials made so far, I should like to explain why we have been induced to continue the work to such an extent.

Reasons for Continuing the Experiment.

According to the recording instruments we had in use, we were working the exhausters in a fairly satisfactory manner, but we could not reduce stopped ascension pipes and the heavy work of auguring, &c., to the degree that we desired.

By the introduction of much more sensitive pressure recording instruments, however, we had recorded for us the fact that our exhausting conditions were not nearly so satisfactory as we had imagined, and it became imperative to improve those conditions.

We began to do this, as described in the early part of the paper, and as trial followed trial, improvements were obtained in the quantity and quality of the gas produced, there was a gradual reduction in the number of stopped ascension pipes and the arduous nature of auguring was reduced.

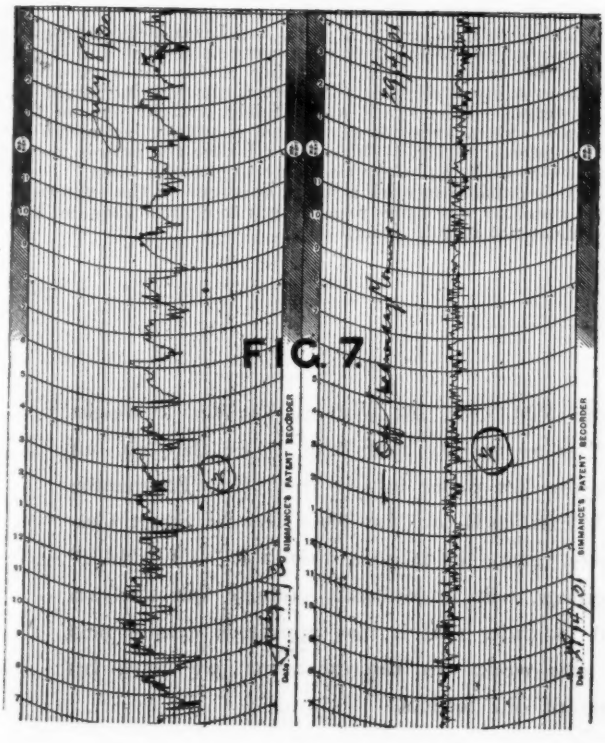


FIG. 7.

A careful examination of the reproduced retort house charts (Fig. 7), which are typical, will show the difference in control prior to this experiment and at present, and we feel sure when we have obtained that fine degree of control which is possible, the benefits that will be obtained can be summarized as follows:—

(1) Pores of the retorts filled with carbon, which prevents indrawing of furnace gases and loss of coal-gas and additionally lengthens the life of the retorts.
(2) Air not drawn in at mouthpieces.
(3) Maximum quantity of gas produced.
(4) Maximum quality of gas produced.
(5) Quantity and quality of gas more regularly produced.
(6) Stopped pipes reduced to a minimum and auguring made easy.
(7) Length of time taken to do the draws reduced, with consequent lengthening of carbonizing periods and increased throughput of coal.

Regarding the third benefit—*i.e.*, maximum quantity of gas produced, our make per ton has increased by 300 c.ft., due entirely to the better controlling conditions brought about as described.

[An addendum to the paper will be published later.]

DISCUSSION.

The PRESIDENT: I am sure we are indebted to Mr. Webb for the interesting résumé of the paper. One thing I am not quite clear about, and that is having encountered such difficulties at the outset, why did he not employ the ordinary method of using the retort house governors. I also cannot quite understand why Mr. Webb had such difficulty in getting the governor bell to operate at the outset, because if the governor bell is properly provided with air-tight floats there is no reason why it should not be a very delicate piece of apparatus. I should also have been glad if Mr. Webb could have given us some particulars of the analyses of the gas before and after the introduction of the apparatus. I was not quite sure whether the analyses he gave us were these.

Mr. WEBB: No; they did not relate to the position before.

The PRESIDENT: Also I should have liked to see a chart from a recording calorimeter showing the effect of variations in the quality of gas, and I should also have liked some particulars of the effect of production of retort carbon, and figures regarding the increased throughput of coal. I hope Mr. Webb will not think I am asking too much, but I think these points will be very interesting to everybody. With regard to the production of the very straight line of the pressure in the retort house, I have employed an Arkon apparatus not only in the retort house but also in the engine house itself. We have one line of main in the retort house working under conditions similar to Mr. Webb's which is about 300 yards from the exhauster house, and the result of the conditions of working was wire drawing of the gas. We had a perfectly efficient retort house governor, but in order to minimize the oscillation and unevenness of pressure we installed an Arkon apparatus actually in the engine house. We endeavoured to make that apparatus control the speed of the exhausters by applying it to the same throttle valve. That was not successful, and it may have been that had I used the apparatus which has been described by Mr. Webb, for operating the throttle in connection with the Arkon apparatus, I might have met with success. But I did not, and what I did was to make the Arkon apparatus control a small by-pass which allowed any momentary fluctuation of pressure produced by the exhausters to pass back into the inlet. Of course, I know the criticism will immediately be that I am wasting steam, and that I am exhausting twice over, but there was only a very small proportion of the gas concerned, and the result has been entirely satisfactory. In fact, it is difficult to see in actual operation if any mechanical apparatus is working on the exhaust main at all.

Mr. C. S. SHAPLEY: It was not my intention to speak, but I thought I would like to say that Mr. Webb's paper was prepared at my behest. Mr. Webb has not yet completed the work, and he was very anxious not to write a paper on it at this stage, but I thought the results he had obtained were of such interest, particularly to the

smaller gas-works—we are not attempting in the paper to teach the larger works anything about carbonizing—that this information of the latest development with regard to pressure in retorts would be valuable. As Mr. Webb mentioned, the question of leakage through retorts has been receiving the attention of Dr. Parker and others, and we do not seem to have got very much information on that subject. I want to congratulate Mr. Webb on the paper. The hour is late, and there is a lot I would like to say, but I will prepare something for the Transactions later. I feel sure, however, that Mr. Webb will complete the paper and put in anything he has not included so far, because we are still experimenting. We have not reached finality, and I think that applies to everything in the Gas Industry. As soon as we think we have reached finality we shall cease to be as prosperous as we are, but we are hoping to do even better than we are at the present time.

Mr. B. R. PARKINSON: This paper is somewhat unique in that its subject matter is confined to one single adjustment of an apparatus. The author has rightly carried his experiment to the extreme limit so that its value might be properly ascertained. Nevertheless, I believe that Mr. Webb is striving after an ideal of which he himself is not fully conscious. I am, therefore, first of all going to try to prove that he is wrong, and then afterwards I hope to succeed in proving that he is right. My remarks refer to ways and means rather than to results.

The range of his governor bell is reduced to practically nil. Surely this must be at the expense of its mechanical advantage in operating the steam valve lever. Theoretically that would appear to take us from one undesirable extreme to another, and I should have expected that the experiments would have ended in establishing a mean or critical ratio of leverage where best results were obtained. Another strange thing is the admission in the paper that the apparatus is not now wholly automatic, periodical adjustments having to be made. May I explain a characteristic of the ordinary gas governor which we all know but perhaps do not fully realize? The reference is equally to pressure and vacuum governors; the principle is the same, and the term pressure will be understood in either its positive or negative sense. In the ordinary type of governor the bell or diaphragm is always actuated by governed pressure—that is to say, pressure which we expect to show on the chart as a straight horizontal line. At the same time, this bell or diaphragm has to work the valve, in this case a steam valve, in other cases a gas valve. Obviously, therefore, if there be any work to be done over the moving of this valve, any friction or inertia to overcome, any pressure to be absorbed, that must be at the expense of the line on the chart. Our first desire would therefore be to design the mechanism without frictional resistance, as light in weight as possible and with mechanical advantage to the bell or diaphragm. But Mr. Webb has added to this idea of cutting out all movement of the bell as though movement involved an appreciable amount of work. Really I do not see the need, for if a bell be light and its displacement negligible, it throws the same pressure in any position of its range, and its movement should scarcely affect the chart. On the other hand, as I have already pointed out, the loss of range may involve pressure absorption by destroying mechanical advantage. That is the problem of the simple type of governor whose bell or diaphragm has all the work to do on the valve and is expected to keep a straight line on the chart.

RELAY GOVERNOR.

Then there is the so-called "relay" type of governor, which employs a bell or diaphragm to control the pressure on the chart but provides an auxiliary source of power to control the valve; pistons actuated by water or oil pressure or an electric motor. Very little range of movement is required with the bell or diaphragm here.

A third type of governor utilizes its ungoverned pressure to work the valve, provided there is sufficient margin of ungoverned over governed. This in its simplicity is the ideal governor and gives a perfect line. It has a main governor and a pilot governor. The latter controls the pressure directly, and the system brings Mr. Webb's idea to its logical conclusion by reducing the movement of the pilot governor bell or diaphragm absolutely to zero. Throughout all variations in the quantity of gas passing it does not move at all. It does all its work by induction of the main governor bell with the help of inlet pressure, itself acting as a catalyst—if I may borrow a chemical term. Unfortunately, this perfect governor has a tendency to hunt at certain speeds, and until the bogey of hunting is overcome it cannot be freely used.

I think it is becoming more generally known that any type of gas governor can be set to control pressure at any distant point by taking what Mr. Webb terms the impulse-pipe from the control bell or diaphragm to that point. No gas passes along this pipe, only pressure influence; and, as Mr. Webb mentions, this pipe should be of ample dimension. Thus the steam governor on the exhauster can be made to control pressure on a small works in the foul main on the retort bench, by carrying its impulse pipe up there; or, on a large works, sectional retort house governors can be fixed on the charging floor and their impulse pipe carried up to the foul main on the bench in the same way.

By the courtesy of the Gas Light and Coke Company, and with their assistance, I have been conducting an experiment at one of their works recently with a scheme which combines the principles of the relay type of governor with that which utilizes its inlet pressure to work the valve. We employ clean gas under pressure for power to work the main governor and have a small pilot governor to govern the vacuum in the foul main. Both governors are on the charging floor, and the impulse pipe from under the 7-in. bell of the pilot governor is taken right up on to the retort bench to the foul main. For the main governor we chose an ordinary existing retort house governor and loaded it with weights instead of the usual counterbalance. The pilot governor is counterbalanced to the required pull; it draws pressure gas through the main governor and discharges into the vacuum mains, actuating the main governor by pneumatic exhaustion and the contrary.

PILOT GOVERNOR BELL.

The small bell of the pilot governor works in one sense without range—that is to say, it take up and retains one position according to the initial adjustment of the apparatus. The range is kept in reserve, and except for some inevitable oscillations, the normal movement to and from the one position may be imperceptible. This again confirms Mr. Webb's idea of reducing range.

This governor hunted at first, and I was inclined to give it up; but one of the junior engineers persevered and found that by increasing the weighting of the main governor (presumably adding to the inertia) the hunting could be overcome. The result was a fairly straight line on the chart. These experiments are not complete, but owing to the interest of Mr. Webb's paper I have the permission of the Gas Light and Coke Company to mention them.

It is possible to work a steam governor on the exhauster in a similar way using pressure gas to control vacuum, but I must not stay to describe it.

For purposes of registered newspaper postage, the P.M.G. in his wisdom imposes a weight limit of 2 lbs. This issue of the "JOURNAL" is as near to that limit as we dare go, but unfortunately we have not been able to include the last paper in the Institution Programme—that by Mr. J. Herbert Clegg, A.M.I.Mech.E., M.Inst.Gas E., on the New Oswald Street Gas-Works of the Burnley Corporation. The Industry, relying as it does upon the "JOURNAL" for a full and complete report of the proceedings, will undoubtedly endorse our decision to hold over Mr. Clegg's valuable contribution in order that it may appear *in extenso* next week. It is dealt with fully in the Review this week. In the meantime, we crave his indulgence, and that of our readers.

CONGRESS OF THE FRENCH GAS INDUSTRY

The Annual Congress of the Association Technique de l'Industrie du Gaz en France took place from April 21 to 25 in Algiers. Summaries of some of the papers presented are given here

CONTROL OF GAS QUALITY.

M. J. Coulom describes the Coulom Calorigraph, a device which records fluctuations in the calorific value of gas. Though the value recorded is not necessarily exact, it can be made almost exact. In any case, the fluctuations recorded are in proper agreement with the actual fluctuations. A spiral of nickel is heated by a Méker burner supplied with the gas and suffers alteration in resistance when its temperature varies due to variation in the calorific value of the gas. The nickel wire is in series with an accumulator, a rheostat, and a recording milliammeter which is graduated in terms of calorific value. Constancy of E.M.F. of the accumulator is very necessary in order that the calibration of the milliammeter may remain correct. This is secured by arranging that the accumulator is maintained at a state of discharge corresponding to the portion of the discharge curve over which the E.M.F. remains most nearly uniform. Hence the accumulator is continuously charged by means of a rectifier worked from the power supply, the charging rate being adjusted so as to equal the discharging rate.

The principle has also been adapted so as to enable automatic control of the calorific value of a mixture of coal gas and water gas to be maintained. For this purpose a series of relays controlling appropriate valves in the generator plant is employed.

THE ROLE OF THE LABORATORY IN GAS-WORKS.

M. P. le Dauphin described the tests which may usefully be undertaken in gas-works, and emphasized the need for adequate analytical and scientific control of the raw materials and manufactured products, the bye-product plant, the coolers, scrubbers and purifiers, and the water supply. The laboratory should also supervise the efficient working of the retorts and producers by taking frequent readings of temperatures and pressures in the combustion flues, waste-gas flues and stack, carrying out analyses of the gas and waste gas, and measuring the water consumed by the producers. By a systematic series of tests, it is possible to establish the most suitable schedule for working the producers at maximum efficiency.

The capital involved in establishing a laboratory and employing a chemist is largely regained by the benefits which accrue. In the case of a group of small or medium-sized works operated by one company, a central laboratory might be maintained in one of the works with the duty of keeping control over the works to which it is attached and of carrying out various analyses for the other works. It would also exercise a periodical control over these works. Nevertheless, each works should be able to control its own settings, scrubbers, purifiers, and gas. The chief chemist should be available to visit any works in case of necessity and would be responsible for check tests and for special work.

CONTROL AND TESTING OF REFRACTORIES IN GAS-WORKS.

M. G. Charlet reviewed the tests employed by the Paris Gas Company in connection with refractory materials. The object of the tests is two-fold—first, the control of the quality of the standard materials employed; and, secondly, the investigation of new products.

Deliveries are inspected for cracks, flaws, and inclusions of fusible matter and dimensions are checked. The tolerances should not exceed ± 2 p.ct. for dimensions greater than 4 in. or ± 1/2 in. for dimensions less than 4 in. Plane surfaces should not exhibit curvature in excess of 1 p.ct.

For sampling, a number of bricks are taken at random to obtain an average sample, and, in addition, bricks which are apparently of the lowest quality are picked out. The samples are tested for refractoriness, after-contraction or expansion, and cold crushing strength. Chemical analysis is generally not required. As regards refractoriness, but little weight is attached to the ordinary test, the under-load test being preferable.

The under-load test is carried out on upright rectangular prisms 4 in. by 2 in. by 2 in., the base of the prism being subjected to the weight of the prism—*i.e.*, approximately to a load of 4 oz. per sq. in. Ten or twelve samples from the same batch may very readily be tested simultaneously in a gas-fired surface combustion furnace. The heating schedule is a fixed one and is controlled by use of a platinum, platinum-rhodium couple, and a recording indicator. Suitable Seger cones are placed at the front and back of the hearth. The test pieces are heated to the cone at which deformation commences, and after cooling down slowly during 15 hours are measured and then broken so that the internal structure may be examined. By this test, firebricks may be divided into several groups corresponding to well-defined conditions of utility in settings. In this test, the temperature of deformation ranges from 1600°-1750° C. in the case of firebricks and generally exceeds 1700° C. in the case of silica bricks.

The cold crushing strength is measured on a 2-in. cube. Cushions of cardboard or rubber are interposed between the test-piece and the plates of the press to secure even distribution of the pressure. The results obtained vary with the nature of the interposed material; hence this should not be varied. When cardboard is employed, the crushing strength obtained for firebricks and silica bricks ranges between 1400 and 5700 lbs. per sq. in.

Tests are also carried out to ascertain the true specific gravity of silica bricks.

In the case of products which have not previously been purchased, additional tests are carried out—namely, macroscopic examination of a polished surface, and determination of the expansion curve under load, the reversible thermal expansion, the apparent specific gravity and porosity, and the resistance to slag attack. In the near future, thermal conductivity and permeability tests and microscopic examination will also be carried out. As regards the expansion under load test, the temperature of commencement of subsidence is of interest. The interval between this temperature and the temperature of collapse is characteristic of the material, being about 300° C. for firebricks and only 30° C. for silica bricks. The temperature of initial subsidence is higher by 300°-400° C. for silica bricks than it is for firebricks. For the test, a Bodin-Méker apparatus heated by gas and compressed air is employed, the furnace being a cylindrical one and capable of attaining a temperature of 1600° C. The test-piece is a rectangular prism approximately 2½ in. high by ¾ in. by ¾ in., and the load applied 30, 70, 140, or 280 lbs. per sq. in.

In the case of firebricks, the temperature of initial subsidence diminishes with increased load. With a load of 30 lbs. per sq. in., the temperature with different products may range from about 1050° C. to about 1250° C. The temperature of complete failure is a little difficult to determine exactly; hence it has been arbitrarily fixed as the temperature at which a contraction of 25 p.ct. is shown. This temperature, also, decreases with increased load and with a load of 30 lbs. per sq. in. ranges between 1350° and 1550° C. approximately.

With silica bricks and loads within the range indicated, the temperatures of initial subsidence and complete failure are practically independent of the load and are very close to each other, being respectively in the neighbourhood of 1550° and 1580° C.

Thermal expansion tests are of great importance in providing information useful in the calculation of expansion joints and the determination of the heating schedule in starting up settings and provide indications as to precautions which must be taken to avoid ill-effects due to sudden volume changes.

Various methods are available for assessing the resistance of bricks to slag attack. The method preferred is to place some of the slagging agent on the surface of the brick in a ring of clay, since it has the advantage of not necessitating the removal of the original surface of the brick. After being heated to the appropriate temperature, the test-piece may be sawn in two for inspection.

PURE IRON AND ITS APPLICATION IN THE GAS INDUSTRY.

M. A. Reynaud discussed the causes responsible for the corrosion of iron and steel, and referred to the fact that present-day steel is much more readily corroded than was

the puddled iron in use in the last century. The relative immunity of this iron was due to its chemical homogeneity and, in particular, to a low content of manganese and sulphur. The importance of homogeneity of chemical composition and physical condition and of uniformity of aeration was emphasized. Armco iron, which is the closest approach to puddled iron, gives better results in gasholder shells than does steel plate, and has been adopted in the construction of many holders in Great Britain, America, and France. Equally good results are obtained in other plant liable to corrosion, and maintenance costs are therefore lowered.

PRESSURE LOSSES IN PIPES OF SMALL DIAMETER.

M. F. Guernut described a preliminary investigation on pressure losses in pipes of small diameter—*e.g.*, pipes of bore ranging up to 1⅜ in. It was shown that the critical velocity with such pipes is sufficiently high to ensure that, in service pipes, except in the case of pipes supplying geysers, the velocity is generally in the stream-line range. Both for stream-line and turbulent flow, pressure losses are greater than are calculated from Monnier's formula, which is generally employed in France, and it is suggested that further work should be carried out with the object of securing the use of more suitable formulæ. Curves were presented showing pressure losses in iron and in lead pipes of different diameter with varying flows of gas.

EFFECT OF STEAMING ON THE LIFE OF THE EXTRACTORS OF GLOVER-WEST RETORTS.

To secure the best steaming results without formation of excessive volumes of liquor, it is desirable to superheat the steam strongly and to reduce its quantity to a minimum. According to M. H. Séranne, the result of this is to cause fracture in the upper part of the helix of the extractor in Glover-West retorts. In settings of eight, fracture occurs first in the hottest retorts—namely, in those nearest the producer—and may become apparent after a life of 44-52 months. Fracture is due to growth of the cast-iron leading to development of porosity and resulting oxidation, and is a result of the high temperature to which the upper part of the extractor is exposed. The use of a special alloy—*e.g.*, one of nickel-copper-chromium—in the upper portion of the extractor is suggested as a remedy. Alternatively, an increase in the height of the retorts is suggested, so that a hot zone of coke might still be present for water gas production, though the lowest part of the coke might be kept below 450°-500° C.

NOTES ON PLANT AND PROCESSES

Hot Patching with E.B. Gun Cement.

A leaflet recently issued by Messrs. E.B. Refractory Cement Company, Ltd., of 147, Corporation Street, Birmingham, explains the firm's cement gun and the gun cement used in conjunction therewith for the purpose of hot patching.

The gun is a single unit containing its own propelling force action, as in the case of the usual Army pattern rifle. The barrel is made of solid drawn steel tubing with extension pieces to give an effective range of 16 ft. The slurry container has a capacity of about 3 ozs., which is discharged at 35 lbs. per sq. in. pressure. The weight of the gun when fully extended is about 16 lbs.

The method of operation, it is stated, is simplicity itself. The slurry holder on the muzzle of the gun is charged with the special plastic cement manufactured by the Company; the operator then inserts the loaded gun through the manhole or door, places the bell mouth of the slurry holder over the crack, and pulls the trigger. The whole operation is a matter of a few seconds.

Also dealt with in the leaflet is the special gun cement which, it is remarked, represents the result of many years' testing with different compounds. The properties the firm have developed are cohesion, adhesion, and strength, and once in position it is claimed that the patch formed by this cement forms a perfect seal.

A Booklet of "Vulcan" Appliances.

The latest catalogue of gas appliances issued by the Vulcan Stove Company, Ltd., of Exeter, is an extremely comprehensive work, running to over 70 pages of matter and containing illustrations, full details, and specifications of a large range of gas cooking and water heating appliances.

The front cover design is very striking, being a coloured reproduction of the firm's advertisement, which appears elsewhere in this issue. The opening sections are devoted to details of the firm's high grade cookers, which can be obtained in stainless finish, and all-enamelled, complete with thermostatic oven heat control, which can be fitted to any of the cookers illustrated in the present publication. Larger types of gas cookers are next dealt with, these also being obtainable in a number of attractive finishes, and, after a section on hotplate plans, the catalogue goes on to describe the cheaper, but none the less efficient, types of cooker in black finish, while in this range also comes the "Exonia" half-ceramic cooker, in which models the cornice, budges, front and door, and stand are in mottled enamel finish.

A section is devoted to large cooking apparatus and hotplates on stands, the publication then going on to deal with grillers and boiling rings, examples of each of which can be obtained in mottled enamel finish. There are also illustrated gas irons, tailors' iron heaters, and soldering iron heaters.

The final sections deal with the water heating side, including wash boilers and geysers, while a complete index concludes this interesting and useful list of "Vulcan" gas appliances.

A New Gas-Operated Refrigerator.

Readers will be interested to learn that Messrs. Electrolux, Ltd., have brought out a new gas-operated refrigerator. This is called the "Freezolux," and it will be sold at a price which will place it within reach of people with modest purses—in fact, it is claimed to be the lowest-priced refrigerator on the market.

Hitherto, refrigerators on account of their price have, to some extent, been looked upon in the light of luxury equipment; but the "Freezolux" will place domestic refrigeration within the reach of the million, for the terms on which this appliance can be obtained will make it easy for almost every consumer to have his own refrigerator. This opens up a new and profitable field to the Gas Industry. It will be especially useful during the summer months when the demand for gas is low; at the same time, as a refrigerator is needed every day in the year, it will mean a general increase in load all the year round.

The construction of the "Freezolux" is interesting. There is no mechanism whatsoever; the usual machinery being replaced by a gas jet. This new model, therefore, follows usual Electrolux construction, the lining of the box being pure porcelain enamel on seamless steel. Galvanized iron shelves are provided giving an area of approximately 3¼ sq.ft. Three ice drawers are fitted, one of which is of a flexible type, each capable of producing 1 lb. of ice per freezing. Insulation of the cabinet is approximately 2¼ in. of expanded cork slab.

The cooling unit has a gas consumption of 2½ c.ft. per hour, thermostatically controlled. A supply of cooling water amounting to three gallons per hour is also necessary. The cooling water is controlled simultaneously with the supply of gas, resulting in average consumptions over 24 hours of approximately 35 to 40 c.ft. of gas and 40 to 45 gallons of cooling water per day of 24 hours under average conditions of use throughout the year.

The cabinet is finished in white washable cellulose, and the door furniture and fittings, which are of robust construction, will be bright chromium plated. The cabinet is provided with feet raising it about 8¾ in. from the ground which has proved to be the most convenient height for the insertion and removal of foodstuffs, and this also greatly facilitates cleaning beneath the cabinet.

GAS MARKETS & MANUFACTURES

Stock Market Report.

[For Stock and Share List, see later page.]

The Stock Exchange commenced business last week with an unsettled feeling existing in most markets, the depression being particularly acute in the Home Railway and Foreign Bond sections. Towards the close, however, a better tone was noticeable; British Funds, which had fluctuated during the week, became firmer; and there were distinct signs of a recovery in the industrial market. The 21-day account, therefore, ended on Friday last under comparatively cheerful conditions.

Gas stocks and shares were again well supported, and prices still continue to harden. A glance at the Stock and Share List will reveal the fact that in many cases transactions have been recorded at prices which amply justify some further appreciation in values. South Shields consolidated again headed the list of increases with a gain of a further 3 points to 114-116 at the local Exchange. Gas Light £1 units increased 3d. to 18s. 9d.-19s. 9d., and Liverpool 5 p.ct. was marked up 1½ points to 101-102 at Liverpool. Gains of 1 point each were made by Alliance and Dublin 4 p.ct. debenture and South Metropolitan 3 p.ct. debenture, and a fractional improvement occurred in Gas Light 4½ p.ct. debenture. A large volume of business was done in Imperial Continental stock at prices ranging from 295 to 330, the closing quotation being 305-325 ex div., a drop of 20 points on the week. At this price the stock presents an attractive investment, and on the basis of last year's dividend of 20 p.ct. yields practically £6 7s.; moreover, as the amount carried forward to this year's accounts is approximately 20 p.ct. on the capital, it can be safely assumed that at least the same rate of dividend will be maintained.

The report and accounts of the Plymouth and Stonehouse Gas-light and Coke Company for the year to March 31 indicate that the Company have had another successful year. The net revenue account shows an available balance of £39,145, against £34,582, out of which the Directors recommend the payment of the following dividends for the last half-year: £8 p.ct. per annum on the ordinary stock, 13s. 6d. per share on the additional shares, and 13s. per share on the new shares. These are at the same rates as the corresponding half-year. These will absorb £16,881, leaving £22,264, against £17,700, to be carried forward. The report records a further increase in gas sales, and also states that the issue during the year of £70,000 5 p.ct. debenture stock was largely over-subscribed. The Company's ordinary stock only is quoted on the London Exchange. The present price is 110-115; and the yield on the current rate of distribution is high at £7 2s. 2d. p.ct. No transactions in this stock have been recorded since March last, and business was done then at the same price as is ruling to-day.

Current Sales of Gas Products.

The London Market for Tar, Tar Products, and Sulphate.

LONDON, *June* 8.

The values of tar products in the London market are unchanged, and remain as on June 1.

Tar Products in the Provinces.

June 8.

The average prices of gas-works products during the week were: Gas-works tar, 17s. 6d. to 21s. 6d. Pitch—East Coast, 44s. 6d. to 45s. f.o.b. West Coast—Manchester, Liverpool, Clyde, 44s. 6d. to 45s. f.o.b.* Toluole, naked, North, 1s. 7½d. to 1s. 7¾d. Coal-tar crude naphtha, in bulk, North, 5⅜d. to 6½d. Solvent naphtha, naked, North, 1s. 3d. to 1s. 3½d. Heavy naphtha, North, 11d. to 1s. Creosote, in bulk, North, liquid and salty, 3½d. to 3½d.; low gravity, 1¼d.; Scotland, 3¼d. to 3½d. Heavy oils, in bulk, North, 5⅜d. to 5⅞d. Carbolic acid, 60's, 1s. 1d. to 1s. 2d. Naphthalene, £10 to £12. Salts, £3 to £5, bags included. Anthracene, "A" quality, 2½d. per minimum 40 p.ct., purely nominal; "B" quality, unsaleable.

* All prices for pitch are now quoted on the basis of f.o.b. In order to arrive at the f.a.s. value at any port, it will be necessary to deduct the loading costs and the tolls whatever they may be.

Tar Products in Scotland.

GLASGOW, *June* 6.

Market conditions are mainly quiet with prices irregular. The inclement weather during the week has had an adverse effect on output of refined tars, &c.

Pitch.—Export price is nominal at about 37s. 6d. per ton f.o.b. Glasgow, and home business is dull at 37s. 6d. per ton f.o.r. works.

Refined tar to Ministry of Transport Specification has been held up during the week owing to weather conditions. Value remains easy at 2⅜d. to 2⅝d. per gallon f.o.r. in buyers' packages.

Creosote.—Demand continues steady in the home market. B.E.S.A. Specification is 2⅜d. to 3d. per gallon; low gravity, 3½d. to 3¾d. per gallon; and neutral oil, 3¼d. to 3½d. per gallon—all f.o.r. in bulk.

Cresylic.—Few orders are being received, but prices are fairly steady. Pale, 97/99 p.ct., is 1s. 3d. to 1s. 4d. per gallon; dark, 97/99 p.ct., 1s. 2d. to 1s. 3d. per gallon; and pale, 99/100 p.ct., 1s. 5d. to 1s. 6d. per gallon—all ex works.

Crude Naphtha.—Production is low and value is 4¼d. to 4¾d. per gallon f.o.r. in bulk.

Solvent Naphtha.—Stocks are high, but quotations remain at 1s. 3d. to 1s. 4d. per gallon for 90/160 grade, and about 1s. 1d. per gallon for 90/190 grade.

Motor Benzole—With few orders passing value is nominal at 1s. 3d. to 1s. 4d. per gallon in bulk.

Pyridines.—90/160 is 3s. to 3s. 3d. per gallon, and 90/140, 3s. 6d. per gallon.

Benzole Prices.

These are considered to be the market prices for benzole:

	s.	d.		s.	d.	
Crude benzole	0	6½	to	0	7½	per gallon at works
Motor ,,	1	1	,,	1	2	,, ,, ,,
Pure ,,	1	5	,,	1	6	,, ,, ,,

Trade Notes.

Brandl-Marischka Meter.

It may be of interest to readers, particularly those present at the paper, "Problems of Modern Gas Distribution," given by Dr. H. Schütte, at the meeting of the Institution of Gas Engineers on June 2, to learn that the sole licence for the manufacturing and selling rights for great Britain and the Colonies, France, Spain, and Belgium for the Brandl-Marischka meter described in this paper, have been secured by Messrs. W. C. Holmes & Co.

Contracts for British Diesel Engines.

Following on the order of the B.B.C. for four Crossley vertical compressorless Diesel engines for the new Scottish Regional Station, come new orders from England, Wales, and the Irish Free State. The Bridport Electricity Works have ordered a 5-cylinder 325-B.H.P. engine for driving an electric alternator, a 3-cylinder unit is to operate near Beaumaris in the Dinmoor Park Quarries of the Minerals Construction Company, Ltd., while the Government Boot Factory at Carlow, I.F.S., have ordered a 3-cylinder set for dynamo drive.

Contracts Advertised To-Day.

Coal.

The Workington Town Council invite tenders for the supply of gas coal. [Advert. on p. 739.]

The City and County Borough of Belfast Gas Department invite tenders for the supply of gas coal. [Advert. on p. 739.]

The Gas Committee of the Sutton-in-Ashfield Urban District Council invite tenders for the supply of coal. [Advert. on p. 739.]

Incandescent Mantles.

The Gas Committee of the Sutton-in-Ashfield Urban District Council invite tenders for the supply of incandescent mantles. [Advert. on p. 739.]

Oil, &c.

The Gas Committee of the Sutton-in-Ashfield Urban District Council invite tenders for engine and cylinder oil, and engine waste. [Advert. on p. 739.]

Piled Foundation and Superstructure.

The Oldham Corporation Gas-Works Committee invite tenders for the work and materials in connection with piled foundation and superstructure for coke storage bunkers. [Advert. on p. 738.]

Steam Tubes and Fittings.

The Gas Committee of the Sutton-in-Ashfield Urban District Council invite tenders for the supply of puddled iron steam tubes and fittings. [Advert. on p. 739.]

Discussion on Mr. Holton's paper (*continued from p. 801*).

this could vary in gas-works practice between wide margins, if there were vertical and horizontal installations.

The presence of rock salt is mainly associated with local alkalinity, and I am surprised that Dr. Smith states that such conditions exist in good coke oven practice, for he advocates sufficient ammonia passing through the bath to neutralize any spray.

The paper pointed out (Statement No. 5) that the capital cost of plant for the semi-direct process was less than for one of the indirect process. The labour costs were also discussed at some length, and I would point out to Dr. Smith the following statement in the paper: "The attendants are not fully employed on sulphate making on the semi-direct process, and a reduction would be brought about if suitable duties could be found for them in the vicinity of the sulphate plant."

The capital costs were also referred to by Mr. H. D. Madden, and I must point out that I submitted a schedule of the capital costs (Statement No. 5 in the Appendix), for the reason that the Partington plant provides sufficient plant for an extension of the carbonizing plant, and therefore was not comparable with a normal 10-million works.

I must refer Dr. Parker to Table No. 5, where, under the heading of "Exhausters," I state that extra power is required on account of the increased back-pressure involved in the adoption of the semi-direct process. I am pleased to note that Dr. Parker anticipates that there will be difficulties in the early working of the de-phenolating plant. These I anticipate, and I hope again to be able to take my courage in both hands and present a detailed statement to the Liquor Effluents and Ammonia Sub-Committee.

In reply to Mr. Botley, the Ammonium Chloride process, as outlined in the paper, is not merely a suggestion, but plant considerably above the experimental stage is now being erected.

With regard to the valued contribution from Dr. Monkhouse, the question of the life of active carbon filters under the conditions existing at Partington will be a matter of more than ordinary interest, but before incorporating them into the scheme, various inquiries were made, and I anticipate a minimum life of one year. The back-pressure thrown by the experimental Raschig rings tower was 3 in. It is of interest to note that the laboratory experiments carried out by Dr. Monkhouse for the extraction of ammonium chloride showed a high portion of polyhydric phenols in the salt obtained, which on oxidation gives a deep red colour to the ammonium chloride. The purifying process that has lately been evolved and mentioned in the paper deals successfully with this impurity.

In reply to Mr. Firth, without further experiment I cannot explain the difference in the oxygen absorption figure of the resultant condensate after using a Crossley fan at the Bradford Road Works and Dr. Monkhouse's experiment with an electrical tar extractor. The installation of an "Arca" regulator in front of the saturator was not taken into consideration, but undoubtedly it would have been successful at the saturator inlet.

The circulating liquor is being maintained at a strength of 14-18 p.ct. of ammonium chloride, not because an equilibrium is reached, but rather because I consider it a safe working figure in the early stages of the operation of the process. In all probability the strength will be increased, but to what extent it is impossible to say at this stage.

The benzole washing process, with carbon filters incorporated to recover the dissolved benzole that would otherwise be lost in the plant, was adopted, since there are a large number of plants operating successfully in Germany and much varied experience has been gained thereby.

As mentioned by Mr. Henshaw, the design of the semi-direct plant at Partington is based on that of many installations operating in the Coke Oven Industry, some of which I reported upon prior to the adoption of the plant. The difficulties encountered were solely due to the dissimilarity of conditions.

I should like to acknowledge with appreciation the attention and care exercised by Messrs. W. C. Holmes & Co., Ltd., in the construction and early operation of the plant, and also the help afforded by various members of my staff in the preparation of the paper.

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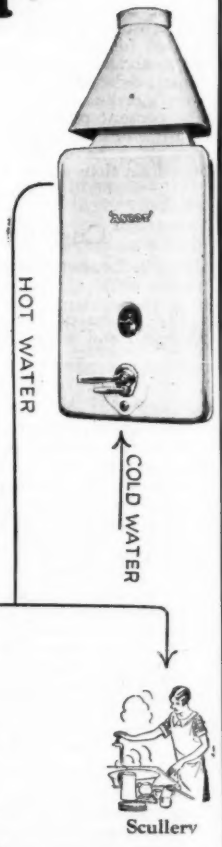

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[For Stock Market Report, see earlier pages.]

Issue.	Share.	When ex-Dividend.	Dividends. Prev. Hf. Yr.	Dividends. Last Hf. Yr.	NAME.	Quotations. June 5.	Rise or Fall on Week.	Transactions. Lowest and Highest Prices During the Week.
£			% p.a.	% p.a.				
171,978	Stk.	Feb. 5	5	5	Aldershot 5 p.c. max. C. ...	77—82	...	...
522,992	,,	,,	4	4	Do. 4 p.c. Pref. ...	75—80	...	...
1,551,868	,,	Apl. 9	7⅞	7⅞	Alliance & Dublin Ord. ...	100—105	...	103—104½
374,000	,,	Jan. 8	4	4	Do. 4 p.c. Deb. ...	72—77	+1	...
522,655	,,	Mar. 5	7	7	Barnet Ord. 7 p.c.	124—129	...	125
300,000	1	Apl. 23	1/4⅛	1/9⅜	Bombay, Ltd.	16/6—18/6	...	17/6
174,500	10	Mar. 5	9	9	Bournemouth 5 p.c. ...	15—16	...	...
500,050	10	,,	7	7	Do. B 7 p.c. ...	12⅜—13⅜	...	12½—12⅛
439,160	10	,,	6	6	Do. Pref. 6 p.c. ...	11¼—11⅝	...	...
50,000	Stk.	Dec. 18	3	3	Do. 3 p.c. Deb. ...	60—63	...	62½
162,025	,,	,,	4	4	Do. 4 p.c. Deb. ...	81—84	...	...
357,900	,,	Mar. 19	7½	7½	Brighton & Hove 6 p.c. Con.	112—117	...	114½—116
371,880	,,	,,	6½	6½	Do. 5 p.c. Con.	104—107	...	...
1,287,500	,,	Feb. 19	5	5	Bristol 5 p.c. max.	95—96[a]	...	...
120,420	,,	Dec. 18	4	4	Do. 1st 4 p.c. Deb. ...	78—80[a]	...	...
217,870	,,	,,	4	4	Do. 2nd 4 p.c. Deb. ...	78—80[a]	...	...
328,790	,,	,,	5	5	Do. 5 p.c. Deb.	99½—100½[a]	...	...
855,000	,,	Apl. 9	7	8	British Ord.	110—115	...	113½—114½
100,000	,,	Dec. 18	7	7	Do. 7 p.c. Pref.	110—115	...	...
120,000	,,	,,	4	4	Do. 4 p.c. Red. Deb. ...	74—77	...	...
450,000	,,	,,	5	5	Do. 5 p.c. Red. Deb. ...	92—97	...	...
160,000	,,	Jan. 8	5	5	Cambridge 5 p.c. Deb. ...	95—98	...	...
100,000	10	May 21	6	8	Cape Town, Ltd.	9—10*	...	9½
100,000	10	May 7	4½	4½	Do. 4½ p.c. Pref. ...	6½—7½	...	...
150,000	Stk.	Dec. 18	4½	4½	Do. 4½ p.c. Deb. ...	72—77	...	...
626,860	,,	Feb. 19	6	6	Cardiff Con. Ord.	96—99	...	...
237,860	,,	Jan. 8	7½	7½	Do. 7½ p.c. Red. Deb. ...	97—100	...	...
157,150	,,	Feb. 19	5	6½	Chester 5 p.c. Ord.	85—90[b]	...	...
98,936	1	May 7	†2/-	†2/-	Colombo, Ltd. Ord.... ...	28/—33/-	...	...
24,500	1	,,	1/4½	1/4½	Do. 7 p.c. Pref.	17/6—19/6	...	...
609,204	1	Apl. 9	1/4½	15'27d	Colonial Gas Assn. Ltd. Ord.	16/—18/-	...	...
296,053	1	,,	1/7⅛	17'67d	Do. 8 p.c. Pref.	17/6—19/6	...	...
2,073,280	Stk.	Feb. 19	6	6	Commercial Ord.	93—96	...	...
475,000	,,	Dec. 18	3	3	Do. 3 p.c. Deb. ...	57—60	...	...
787,560	,,	Feb. 19	7	7	Croydon sliding scale ...	108—111	...	...
453,100	,,	,,	5	5	Do. max. div.	82—85	...	...
542,270	,,	Mar. 5	7	10	Derby Con.	120—123[c]	...	...
55,000	,,	Dec. 18	4	4	Do. Deb.	65—70[c]	...	...
209,000	,,	Mar. 5	5	5	East Hull Ord. 5 p.c. ...	72—75	...	...
1,002,180	,,	Mar. 19	†4	†6½	European, Ltd.	85—95	...	87½—93¾
18,953,033	,,	Feb. 19	5⅝	5⅝	Gas Light & Coke 4 p.c. Ord.	18/9—19/9[f]	+/3	19/—19/6
2,600,000	,,	,,	3½	3½	Do. 3½ p.c. max.	64—67	...	65½—66¼
4,294,691	,,	,,	4	4	Do. 4 p.c. Con. Pref. ...	78—81	...	80½
5,694,095	,,	Dec. 18	3	3	Do. 3 p.c. Con. Deb. ...	61—64	...	62½—64
3,642,770	,,	,,	5	5	Do. 5 p.c. Red. Deb. ...	101—104	...	...
2,500,000	,,	—	—	—	Do. 4½ p.c. Red. Deb. ...	96—98	+½	96½—97½
161,480	,,	Mar. 5	10	10	Harrogate Cons. 10 p.c. max.	158—163	...	...
82,500	,,	Mar. 19	7	7	Hastings & St. L. 5 p.c. Conv.	98—103	...	...
258,740	,,	,,	5½	5½	Do. 3½ p.c. Conv.	82—85	...	...
70,000	10	Oct. 9	‡	10	Hongkong & China, Ltd. ...	13—14	...	...
213,200	Stk.	Mar. 5	6	6	Hornsey Con. 3½ p.c. ...	91—94	...	...
2,800,000	,,	May 21	15	25	Imperial Continental Cap.	305—325*	+20	295—330
223,130	,,	Feb. 5	3½	3½	Do. 3½ p.c. Red. Deb.	78—83	...	...
235,242	,,	Mar. 5	8½	8½	Lea Bridge 5 p.c. Ord. ...	127—130	...	...
2,145,907	,,	Feb. 19	6	6	Liverpool 5 p.c. Ord. ...	101—102[b]	+1½	...
600,000	,,	Mar. 19	7	7	Do. 7 p.c. Red. Pref.	98½—100¼[b]	...	...
165,736	,,	Feb. 19	9	9	Maidstone 5 p.c. Cap. ...	128—133	...	...
63,480	,,	Dec. 18	3	3	Do. 3 p.c. Deb. ...	54—57	...	...
75,000	5	Dec. 4	†10	†10	Malta & Mediterranean ...	6—6½	...	...
392,000	—	Apl. 2	5½	5½	Metropolitan (of Melbourne) 5½ p.c. Red. Deb.	86—89	...	...
675,000	Stk.	May 21	†6	†6	Montevideo, Ltd.	90—100*	...	...
2,061,315	,,	Mar. 5	5	5⅜	Newcastle & Gateshead Con.	16/3—16/9d[f]	...	...
682,856	,,	,,	4	4	Do. 4 p.c. Pref. ...	74—75d	...	...
691,705	,,	Jan. 8	3½	3½	Do. 3½ p.c. Deb. ...	69½—70½d	...	...
277,285	,,	May 7	5	5	Do. 5 p.c. Red. Deb.	98—100d	...	...
199,940	,,	Mar. 5	7½	7½	North Middlesex 6 p.c. Con.	115—120	...	...
396,160	,,	Feb. 5	5	5	Northampton 5 p.c. max. ...	74—79	...	...
300,000	,,	Apl. 23	9	7	Oriental, Ltd.	100—105	...	...
60,000	5	13 May, '15	—	—	Ottoman	0—½	...	...
205,162	Stk.	Dec. 18	8	8	Plym'th & Stonehouse 5 p.c.	110—115	...	...
424,416	,,	Feb. 19	8	8	Portsm'th Con.Stk. 4 p.c.Std.	122—127	...	...
241,446	,,	,,	5	5	Do. 5 p.c. max.	78—81	...	...
686,312	,,	Jan. 22	4	4	Primitiva 4 p.c. Rd. Db. 1911	85—88	...	...
389,813	,,	Dec. 18	4	4	Do. 4 p.c. Cons. Deb.	85—88	...	86½—87
150,000	10	Apl. 9	6	6	San Paulo 6 p.c. Pref. ...	8—8½	...	...
1,736,968	Stk.	Mar. 19	6½	6½	Sheffield Cons.	105—107[e]	...	...
95,000	,,	Jan. 8	4	4	Do. 4 p.c. Deb.	79—81[e]	...	...
90,000	10	June 5	‡4	‡5	South African	4—6	...	...
6,709,895	Stk.	Feb. 5	5	7½	South Met. Ord.	102½—104½	...	102¾—103½
1,135,812	,,	,,	6	6	Do. 6 p.c. Irred. Pf.	113—116	...	114—115
1,895,445	,,	Jan. 8	3	3	Do. 3 p.c. Deb. ...	61—64	+1	62½
784,000	,,	Mar. 5	6½	6½	Do. 6½ p.c. Red. Db.	98—100	...	...
1,000,000	,,	Jan. 22	—	4	Do. 5 p.c. Red. Deb.	100—103	...	101¾
91,500	,,	Mar. 5	8½	8½	South Shields Con.	114—116[d]	+3	...
1,543,795	,,	Feb. 19	6½	6½	South Suburban Ord. 5 p.c.	102—105	...	103
668,837	,,	Dec. 18	5	5	Do. 5 p.c. Deb.	101—104	...	102
647,740	,,	Feb. 19	5	5	Southampt'n Ord. 5 p.c. max.	77—80	...	79—80
121,275	,,	Dec. 18	4	4	Do. 4 p.c. Deb.	75—78	...	...
179,014	,,	Mar. 5	8	8	Sutton Ord.	120—130	...	...
94,500	,,	Jan. 8	5	5	Do. 5 p.c. Deb.	96—99	...	...
250,000	,,	Mar. 5	7	7	Swansea 7 p.c. Red. Pref. ...	96—99	...	...
200,000	,,	Dec. 18	6½	6½	Do. 6½ p.c. Red. Deb.	100—103	...	...
1,076,490	,,	Mar. 5	6⅝	6⅝	Tottenham District Ord. ...	102—106	...	...
150,000	,,	,,	5½	5½	Do. 5½ p.c. Pref. ...	101—104	...	...
199,005	,,	Dec. 18	4	4	Do. 4 p.c. Deb. ...	77—80	...	...
85,701	,,	Mar. 19	6	6	Tuscan, Ltd., 6 p.c. Red. Db.	74—79	...	...
310,694	,,	Mar. 5	7	7	Uxbridge, Maidenhead, & Wycombe 5 p.c.	102—107	...	...
88,330	,,	,,	5	5	Do. 5 p.c. Pref. ...	88—93	...	90
1,329,220	,,	Mar. 5	7	7	Wandsworth, Wimbledon, and Epsom Cons. ...	113—116	...	...
426,000	,,	,,	5	5	Do. 5 p.c. Pref.	97—100	...	99
1,013,464	,,	Dec. 18	5	5	Do. 5 p.c. Deb.	100—103	...	102—102½

Quotations at:—*a.*—Bristol. *b.*—Liverpool. *c.*—Nottingham. *d.*—Newcastle. *e.*—Sheffield. *f.*—The quotation is per £1 of stock. * Ex. div. † Paid free of income-tax. ‡ For year. ⅛ Div. = 10 p.ct. p.a. less tax and less tax on interim dividend.

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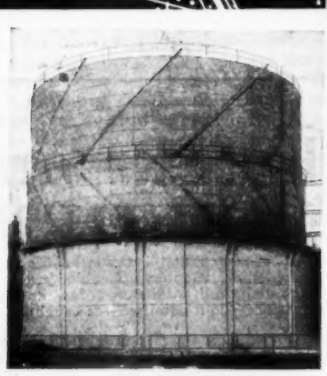

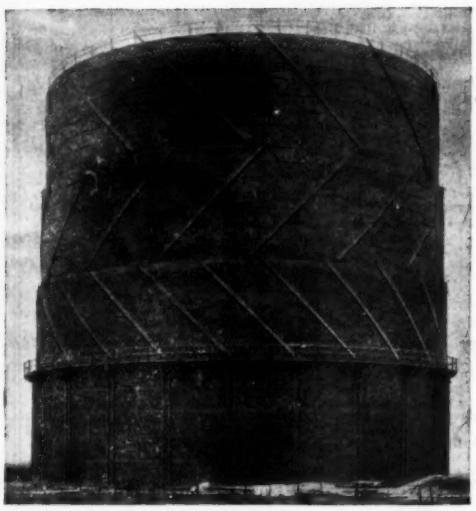

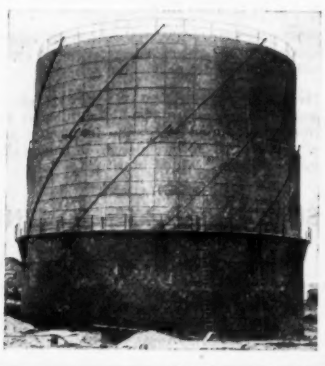

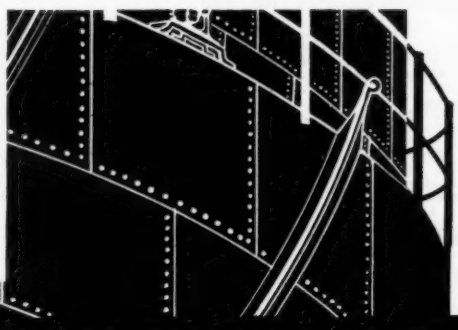

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15 THOMAS CALORIMETERS

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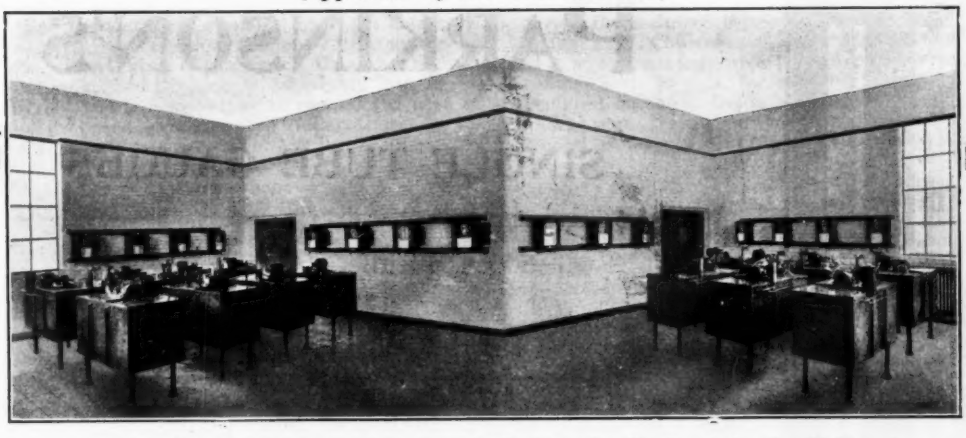

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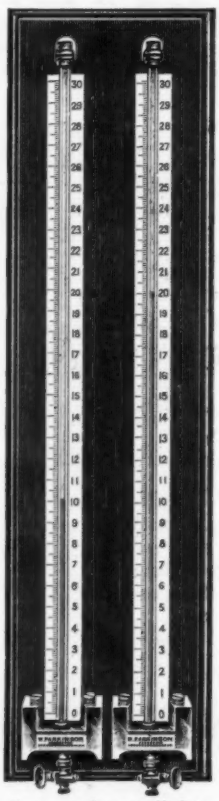

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